Coastal and Estuarine Resource Condition Assessment in the NRM South Region: Project Directions

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Executive Summary

The project to develop and implement a framework to measure change in marine, coastal and estuarine water quality aims to produce a framework with a standardised protocol for monitoring estuaries and coastal waters in the NRM South Region. This discussion paper is the first step in this process. It provides a review of the available information for key estuaries and coastal areas in the Region (including data from Local and State government, community groups, industry and research institutes). As there are not enough resources to monitor all estuaries in the region, this discussion paper also suggests priority estuaries and coastal waters for monitoring.

The suggested locations for implementing the Coastal and Estuarine Resource Condition Assessment (CERCA) framework are:

- Great Swanport/Moulting Lagoon (Glamorgan Spring Bay Council, highly representative and moderate condition, RAMSAR listed wetland, baseline assessment of Shelbourne Bay conducted in 2005 with support from Parks and Wildlife, DPIW, TAFI and Aquenal Pty. Ltd.)
- Little Swanport (Glamorgan Spring Bay Council, moderate condition, estuarine monitoring currently being conducted by TAFI, TSQAP and the oyster farmers)
- Pitt Water/Orielton (Clarence City Council/Sorell Council, poor condition, RAMSAR listed wetland, previously monitored by TAFI, currently being monitored by TSQAP)
- North West Bay (Kingborough Council, poor condition, baseline assessment conducted by TAFI and Council in 2002, fish farm monitoring)
- Port Cygnet (Huon Valley Council, poor condition, some estuarine monitoring being conducted by community, TSQAP and fish farmers)

These locations have been proposed based on the activities occurring and support from stakeholders including community groups, councils, industry, and consultants.

The Derwent and Huon estuaries received the highest priority in the selection process, however since large-scale studies, programs and/or frameworks already exist in these locations, they were excluded from selection. Other high scoring locations were also eventually excluded to maintain geographic spread throughout the Region or because of their remoteness (e.g. Bathurst Harbour).

This discussion paper aims to ensure that all the water quality monitoring and related work that has already been done is recognised in this project, and that the project outcomes meet the needs of key stakeholders. We would appreciate comments from stakeholders, positive and negative, about the process identified for developing the CERCA framework, and the key estuaries we have suggested to commence the monitoring program.

Contents

Acronyms and Abbreviations

ABS	Australian Bureau of Statistics
ACDC	Assessment Committee for Dam Construction
ANZECC	Australian and New Zealand Environment Conservation Council
ASQAP	Australian Shellfish Quality Assurance Program
AusRivAS	Australian River Assessment System
BOM	Bureau of Meteorology
CFEV	Conservation of Freshwater Ecosystem Values
COAG	Council of Australian Governments
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEP	Derwent Estuary Program
DHHS	Department of Health and Human Services
DPIWE	Department of Primary Industries, Water and Environment
DPIW	Department of Primary Industries and Water
DTAE	Department of Tourism, Arts and Environment
ECA	Estuarine Catchment Area
EDA	Estuarine Drainage Area
EHO	Environmental Health Officer
EPHC	Environment Protection and Heritage Council
ICV	Integrated Conservation Value
IMCRA	Interim Marine and Coastal Regionalisation for Australia
MPA	Marine Protected Area
NWQMS	National Water Quality Management Strategy
NI	Naturalness Index
NHT	Natural Heritage Trust
NRM	Natural Resource Management
NRMMC	Natural Resource Management Ministerial Council
PEVs	Protected Environmental Values
Ramsar	Convention on Wetlands, signed in Ramsar, Iran, in 1971
RCV	Representative Conservation Value
SCAT	Southern Coastcare Association of Tasmania Inc.
SERM	Simple Estuarine Response Model
SKM	Sinclair Knight Merz
SoE	State of Environment
STP	Sewage Treatment Plants
TAFI	Tasmanian Aquaculture and Fisheries Institute
TAFS	Technical And Facilitation Support officers
TASVEG	Tasmanian Vegetation Mapping Program
TFIC	Tasmanian Fishing Industry Council
TSQAP	Tasmanian Shellfish Quality Assurance Program
WIST	Water Information System of Tasmania
WHA	World Heritage Area
WQOs	Water Quality Objectives

Introduction

Objectives for a CERCA program in NRM South

The development of a standardised means of collecting, analysing and presenting coastal and estuarine water quality information has been identified as a key need for southern Tasmania. This project – undertaken by the Tasmanian Aquaculture and Fisheries Institute on behalf of NRM South – seeks to fulfil this goal by developing a monitoring program for the coastal and estuarine environments of the Southern NRM Region of Tasmania.

Project description

This project proposes a water quality framework for southern Tasmania by developing a monitoring and evaluation program for key estuaries and coastal waters. This Coastal and Estuarine Resource Condition Assessment (CERCA) program is being developed through extensive consultation with State Government, Local Government, industry and community groups and by collating and assessing available information on water quality and condition of estuaries and coastal waters. The monitoring program is being developed using methods recommended by the Waterwatch Australia Technical Manual and indicators developed by the Tasmanian Coastal, Estuarine and Marine Indicators Working Group. Baseline data will be collected and a monitoring program instigated. An interactive, centralised database for water quality data will also be established.

The overall anticipated outcome, of which this project is a component, is better management of Tasmania's water resources by having a standardised monitoring program for water quality, and a single database that is readily accessible to all stakeholders. This will require ongoing and extensive communication with State and Local Government, community groups, industry and other interested stakeholders. Sharing resources, knowledge and data is critical to the achievement of this outcome.

Purpose of the document

This discussion paper provides a review of existing monitoring in catchments and marine and estuarine habitats and makes recommendations for priority locations to initiate a CERCA program. A number of factors were considered to determine priorities, which can be broken into three parts: (a) significance of the location, (b) practicality of monitoring, and (c) capacity for collaboration. The considerations are quite broad and may be conflicting, reflecting the wide range of issues and potential uses of estuaries and coastal waters in the Region. This process will define the direction of the CERCA program and requires comment by the key stakeholders. A comprehensive report including detailed descriptions of the Region and background information for the development of an

integrated and comprehensive CERCA framework for southern Tasmania has been written and can be provided on request.

This document also provides a link to the freshwater monitoring programs being conducted by research organisations, government and community groups. Linking the freshwater and estuarine/coastal waters monitoring programs together adds value to both programs and will hopefully lead to the development of one standard monitoring program and database for water quality in Tasmania.

Currently there is a lack of water quality data, and there are no standardised monitoring programs for the general health of Tasmanian estuarine, coastal and marine waters, resulting in a wide variety of parameters being measured with no defined standard methodology, quality checking or collation of data. The spatial and temporal scales of sampling are also widely variable. As a consequence, the value of the data collected to date has been significantly reduced because comparisons between locations and over time are generally not possible.

Partnerships

This discussion paper provides the basis for a collaborative approach to develop, document and implement standardised protocols appropriate for expertise- and community-based long-term monitoring of a range of marine and estuarine habitats. The monitoring of coastal habitats by communities, who are supported by expert mapping, training, scientific research and advisory functions of government, is integral to the assessment of health of coastal habitats and management of coastal resources (Zeller *et al*. 2001). Best practice models for monitoring will be developed through partnerships between agencies, industry and the community, including Coastcare, Landcare, Waterwatch and other networks.

Partnerships in coastal monitoring provide a mechanism for communication and allow stakeholders to take greater responsibility for management of their local coastal ecosystems (Zeller *et al*. 2001). Support from Local and State government, industry and the community is fundamental to providing rigorous long-term data series on ecological indicators for improved management of coastal habitats and waterways at a local level (Zeller *et al*. 2001).

For this project, partnerships are being developed across stakeholder groups of the NRM South coastal and estuarine waters. Collaboration will continue, with input from:

- NRM South
- Australian Government (Natural Heritage Trust)
- University of Tasmania (including Tasmanian Aquaculture and Fisheries Institute)
- State Government
    - Department of Primary Industries and Water (DPIW)
    - Department of Tourism, Arts and Environment (DTAE)
    - Department of Health and Human Services (DHHS)
        - Tasmanian Shellfish Quality Assurance Program (TSQAP)

- Local councils
  - Huon Valley
  - Kingborough
  - Hobart
  - Brighton
  - Glenorchy
  - Derwent Valley
  - Clarence
  - Sorell
  - Tasman
  - Glamorgan Spring Bay
- Commonwealth Scientific and Industrial Research Organisation (CSIRO)
- Geoscience Australia and Coastal CRC (e.g. OzEstuaries)
- Community groups and bodies (e.g. Southern Coastcare Association of Tasmania Inc. and individual groups)
- Industries (e.g. shellfish and finfish aquaculture, agriculture, viticulture and other industrial enterprises).

Establishing and maintaining a successful water quality monitoring program involves many challenges, which are often associated with limited resources. It is difficult for agencies to deliver long-term, ongoing environmental monitoring programs and there is a potential for major gaps to develop in the program. If supported, industry, government and community partnerships that monitor water quality can provide benefits, such as:

- participation in the management of coastal ecosystems
- increased community understanding of the connections between coastal, estuarine and catchment issues
- the generation of baseline data and ongoing monitoring of the status and health of coastal ecosystems
- the creation of a focus for communities, industries and government to work together in managing the coastal zone sustainably

Project Outline: Developing a CERCA framework

Step 1: Develop communication strategy

Key stakeholders have been identified and a strategy developed to communicate specific information to these groups (see Appendix 1).

Step 2: Review existing data and information

Available literature on the status and health of coastal ecosystems (estuaries and coastal waters) in the Region has been reviewed and collated, including the identification of existing monitoring efforts (Temby and Crawford 2006). This is essential to devising ways in which monitoring can be coordinated and expanded. This process also identifies data deficiencies that may need to be overcome.

Metadata and information have been provided by the State Government, especially the Department of Primary Industries and Water (DPIW) and the Department of Tourism, Arts and Environment (DTAE) and the Tasmanian Shellfish Quality Assurance Program (TSQAP) in the Department of Health and Human Services (DHHS), Local Government, community groups, industries, the National Land and Water Audit (OzEstuaries) database, and Tasmanian Aquaculture and Fisheries Institute (TAFI). Historical databases and other existing data will also be used to assess baseline conditions.

Wherever possible, existing monitoring efforts have been integrated, however there is limited background information and baseline data available to help determine environmental issues and trends in the NRM South coastal waters. The monitoring programs that do exist include ongoing monitoring of a limited number of environmental variables and snapshots (one-off studies). The collation of information has allowed gaps to be identified and given us the opportunity to suggest ways in which these gaps could be filled within the time and resource limits of the stakeholders.

Step 3: Evaluation of values and threats in key estuarine and coastal areas

In addition to the collection of baseline data, several programs have also undertaken studies to determine the ecological, economic, social and political values of estuaries and coastal areas. Regional stakeholders have previously drafted Protected Environmental Values (PEVs) for the catchments, estuaries and coastal areas, in accordance with the requirements of the *State Policy on Water Quality Management 1997*.The Conservation of Freshwater Ecosystem Values (CFEV) Project have developed conservation management priorities for freshwater dependant systems including estuaries and saltmarshes. The CFEV priorities and the PEVs identify the current uses and values of the catchments and estuaries, and provide supporting information for the development of monitoring objectives and performance criteria contained within this discussion paper.

Consultation with stakeholders to identify gaps in knowledge and threats to water quality, and to gain further information on those attributes not evaluated by other programs is ongoing. An evaluation of the values of – and threats to – southern Tasmanian coastal environments is provided in this discussion paper.

Step 4: Identification of priority locations for monitoring

At any one time it is unlikely that there will be sufficient resources to monitor all waters in the Region. It is therefore necessary to determine which estuaries and coastal waters are the priority for monitoring and are representative of the Region. This discussion paper identifies potential estuaries/coastal waters for monitoring and assessment.

Step 5: Selection of monitoring methods

Monitoring methods have been selected using indicators developed and evaluated by the Tasmanian Coastal, Estuarine and Marine Indicators Working Group (Tasmanian Indicator Compendium 2006), which are a sub group of the National set of indicators. These indicators have been developed to assess the status and trends of estuarine and coastal resources. The methods for monitoring each indicator have been based on a report that has been prepared by Christine Crawford at TAFI, which provides information from a user's perspective on monitoring each indicator in Tasmania (Crawford 2006).

The indicators selected include:

- Temperature (profiles)
- Salinity (profiles)
- Dissolved oxygen (profiles)
- Nutrients in the water column
- Turbidity (triplicate)
- pH
- Chlorophyll-a
- Pathogens
- Fauna and flora species abundance
- Habitat extent

Step 6: Preparation of a draft monitoring framework

The aim of the monitoring framework is to define the monitoring goals and to develop a system for standardised monitoring of estuaries and coastal waters. For the purposes of this framework the Region has been divided into manageable areas (municipalities). The requirements for baseline assessment and monitoring of estuarine and marine coastal waters have been determined in conjunction with stakeholders. These requirements have been identified at two levels, which should be conducted in close cooperation – preferably as one coordinated monitoring program:

- community-based monitoring, and
- expertise-based monitoring.

A schedule of activities will be developed to implement recommendations, including information on who monitors, where and how they monitor (location) and what parameters, the frequency of monitoring and length of time over which monitoring is to be conducted for each parameter.

It is recommended that the community be involved in monitoring easily measured environmental parameters and keeping records of significant events (e.g. algal blooms, storm/erosion events, fish kills), while the expertise-based program involves monitoring parameters that require specialist knowledge and funding for analysis (e.g. chlorophyll-a and nutrients). The community program is based on the methods recommended in the Waterwatch National Technical Committee Manual, Module 7 – Estuarine Monitoring.

The expertise monitoring program is based on recommendations from the Tasmanian Community Estuarine and Marine Indicators Working Group – established in early 2005 to recommend a suite of indicators for monitoring the condition of representative coastal, estuarine and marine environments in Tasmania. This Group developed draft estuarine, coastal and marine indicators from the National Monitoring and Evaluation Framework. Through an earlier project, the Coastal CRC was commissioned by the Australian Government to identify indicators for coasts and estuaries. The CRC's report (Scheltinga *et al.* 2004) identifies 32 indicators for target in coastal and estuarine areas. The Tasmanian Coastal Estuarine and Marine Indicators Working Group has recommended a suite of indicators (based on the Coastal CRC's national set) that will meet NRM reporting requirements in Tasmania and contribute towards developing a nationally agreed approach (Tasmanian Indicator Compendium 2006).

A feedback mechanism will be developed, where monitoring results, both positive and negative, will be made available to the general community to share project information (e.g. a report card). This mechanism will need to allow results and interpretations to be presented to relevant stakeholders, managers and scientists in a form that promotes improvements.

Step 7: Development of the implementation strategy

We will develop an implementation strategy to consider ongoing aspects such as program management. This step is where partnerships become extremely important, as implementation will require co-operation amongst stakeholders. Stakeholders will be encouraged to determine their capacity for water quality monitoring and/or their capacity to contribute to the overall facilitation of a CERCA program in NRM South. They will also be encouraged to take a more co-ordinated approach to working in partnerships.

Step 8: Testing the CERCA program

Rigorous field testing by both expertise-based and community groups is essential in evaluating the success of the CERCA framework. An assessment of all aspects of the data collection, analysis and presentation provides the basis for framework modification and training needs. The selected areas for monitoring include key estuaries and coastal areas and areas at risk of degradation. Relatively unimpacted areas are also included to provide a reference site for comparison. Data from relatively unimpacted areas are important for determining rates and level of change in areas under threat, and for assessing the effect of human activities on water quality.

Step 9: Establish an interactive database for water quality

A centralised database for water quality will be developed with existing water quality information systems (e.g. Hydstra database with outputs through "WIST").

Step 10: Develop trigger levels and guidelines

Water quality trigger levels will be recommended and can be used as a preliminary step towards the development of WQOs by DTAE.

Estuaries and coastal waters of the Southern Region

Estuaries and coastal waters are a valued resource in Tasmania. However activities within these systems and their catchments can cause water quality degradation and therefore can pose a threat to these resources. In the NRM South Region of Tasmania, the types of estuaries and coastal waters include coastal inlets, open embayments, drowned river valleys, barrier estuaries, river estuaries and coastal lagoons (Table 1).

Table 1. Geomorphic forms of key estuaries and coastal waters in the NRM South Region.

Estuary	Geomorphic form
Bathurst Harbour	Microtidal drowned river valley
Blackman Bay	Marine inlet/bay
Browns River	Small, open river estuary
Bryans lagoon	Barred, low salinity
Buxton	Barred, low salinity
Carlton	Marine inlet/bay
Catamaran	Small, open river estuary
Cloudy Bay Lagoon	Marine inlet/bay
Cockle Creek	Open embayment
Crookes	Marine inlet/bay
Denison	Barred, low salinity
D'Entrecasteaux River	Small, open river estuary
Derwent	Microtidal drowned river valley
Earlham Lagoon	Hypersaline lagoon
Esperance	Open embayment
Freney Lagoon	Barred, low salinity
Freshwater Lagoon	Barred, low salinity
Garden Island	Open embayment
Great Swanport/Moulting Lagoon	Marine inlet/bay/lagoon
Grindstone	Hypersaline lagoon
Huon	Microtidal drowned river valley
Lisdillon	Barred, low salinity
Little Swanport	Marine inlet/bay
Louisa Creek	Open embayment
Louisa River	Open embayment
Lune River	Open embayment
Meredith	Barred, low salinity
New River Lagoon	Large open microtidal river
Norfolk Bay	Open embayment
North West Bay	Marine inlet/bay
Oyster Cove/Kettering	Open embayment
Payne Bay	Open embayment
Pipe Clay Lagoon	Coastal lagoon
Pirates Bay	Open embayment
Pitt Water/Orielton	Modified embayment/lagoon
Port Arthur	Open embayment
Port Cygnet	Open embayment
Prosser	Small, open river estuary
Saltwater Lagoon	Barred, low salinity
South Cape Rivulet	Small, open river estuary
Southport Lagoon	Marine inlet/bay/lagoon
Spring Bay	Marine inlet/bay
Stony	Barred, low salinity

Edgar *et al*. (1999) investigated 111 estuaries/coastal waters across Tasmania – 39 of these are located in the Southern NRM Region. These 39 estuaries and embayments and other key coastal areas can be broken into groups according to where they are located in terms of Municipality (Figure 1), and catchment (Figure 2) (NRM South 2004).

The estuaries, coastal lagoons and embayments included in this review were selected after consultation with stakeholders and consideration of their resource values and threatening processes. A full description of the NRM South Region, the main estuaries and coastal waters in the Region, and the values of and threats to estuaries and coastal waters is available on request (Temby and Crawford 2006).

Figure 1. Municipalities within the NRM South Region in Tasmania.

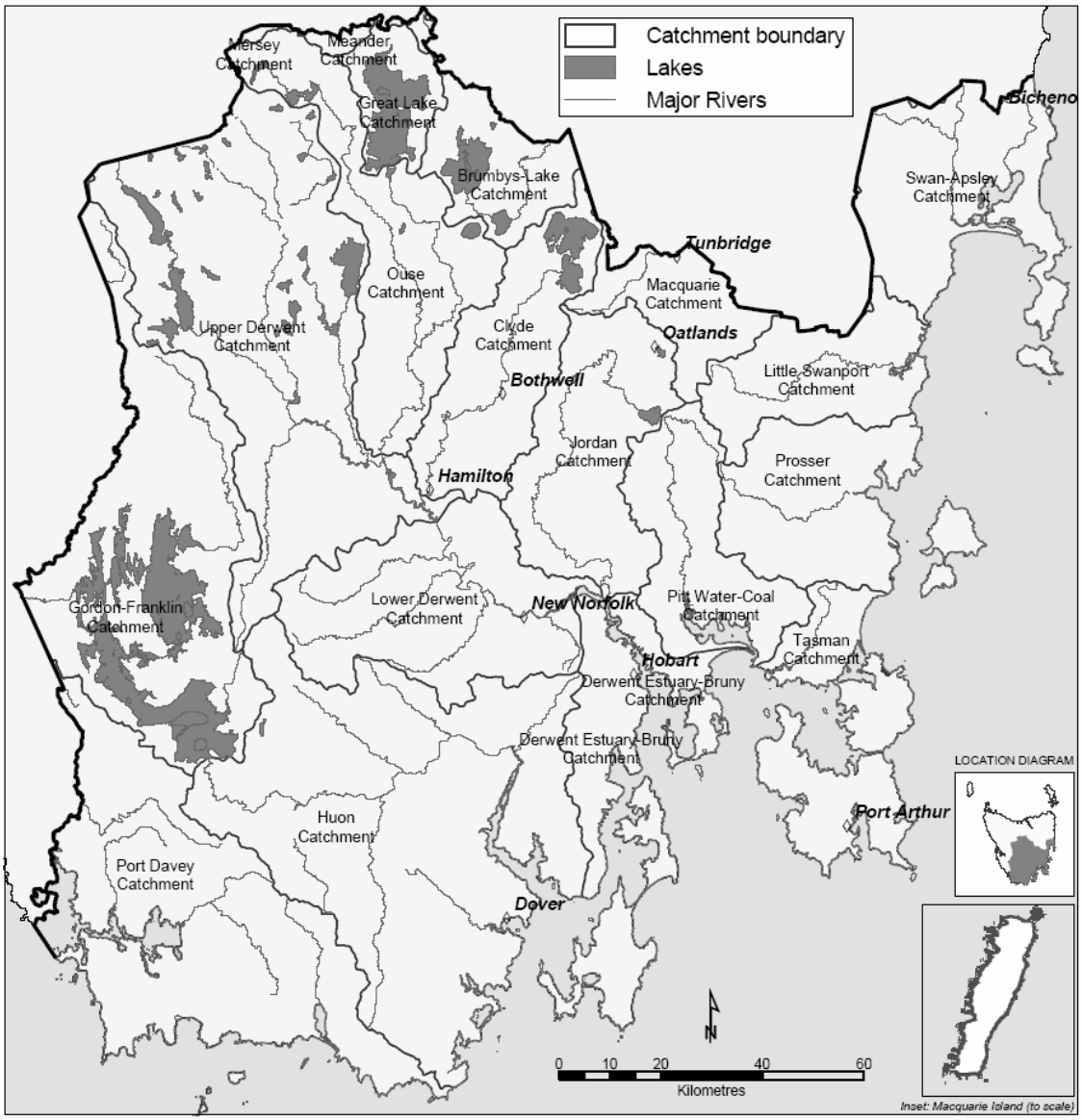

Figure 2. Catchments within the NRM South Region in Tasmania (NRM South 2004).

Table 2 provides a summary of the activities and issues that we have identified within coastal waters, estuaries and catchments that have the potential to effect water quality in NRM South. A description of each potential monitoring location is provided in the more comprehensive version of this report (Temby and Crawford 2006). A summary is provided in Table 3. The CFEV Project has determined land tenure security for most of the estuaries considered here. This is based on land use, ownership and area of reserve(s) in the catchment. Land tenure security can be used to infer the degree of "threat" to particular systems.

Table 2. Summary of the activities and issues that have the potential to affect water quality in coastal waters, estuaries and their catchments for NRM South.

Estuary	Mining	Forestry	Waterway modification	Cropping	Dairy & other agriculture	Marine Farming	Other Industry	Stormwater and/or sewage	Waste disposal sites
Bathurst Harbour	X								
Blackman Bay				X	X	X			
Browns River			X		X		X	X	
Bryans Lagoon									
Buxton		X		X	X				
Carlton				X	X			X	
Catamaran		X		X	X				
Cloudy Bay Lagoon						X			
Cockle Creek									
Crookes				X	X				
Denison				X	X			X	
D'Entrecasteaux River		X		X	X	X			
Derwent		X	X	X	X		X	X	X
Earlham Lagoon					X				
Esperance		X	X	X	X	X			
Freney Lagoon									
Freshwater Lagoon									
Garden Island		X		X	X				
Great Swanport				X	X	X	X		
Grindstone					X				
Huon	X	X	X	X	X	X	X	X	X
Lisdillon					X	X			
Little Swanport		X		X	X	X			
Louisa Creek									
Louisa River									
Lune River	X	X		X	X	X			
Meredith				X	X			X	
New River Lagoon									
Norfolk Bay						X			
North West Bay		X	X	X	X	X			
Oyster Cove		X	X	X	X		X		
Payne Bay									
Pipe Clay Lagoon				X	X	X		X	
Pirates Bay							X		
Pitt Water			X	X	X	X		X	
Port Arthur		X		X	X		X		
Port Cygnet		X		X	X	X			
Prosser		X	X	X	X				
Saltwater Lagoon								X	
South Cape Rivulet									
Southport Lagoon									
Spring Bay		X		X	X		X	X	
Stony				X	X				

Table 3. Description summary of estuaries and coastal waters in NRM South.

	Classification (Heap *et al.* 2001)	Condition (Heap *et al*. 2001)	Conservation rating *	Land tenure security (CFEV)	Total entrance width (km)	Area (km²)	Perimeter (km)	Estuary width (km)	Estuary length (km)
Bathurst Harbour	Tide dominated	Near pristine	A	High	1.49	67.23	137.50	7.54	24.77
Blackman Bay	Wave dominated	Modified	C	Low	0.53	27.18	43.55	4.28	10.99
Browns River	Wave dominated	Extensively modified	E	Low	0.3	0.10	1.47	-	0.66
Bryans Lagoon	Wave dominated, Stand plain	Near pristine	A	High	2.61	0.33	6.78	0.42	2.28
Buxton	River and wave dominated	Modified	C	Low	2.63	0.12	2.39	-	0.99
Carlton River	Wave dominated	Modified	D	Low	0.11	1.69	15.18	0.59	6.66
Catamaran	Wave dominated	Near pristine	B	Medium	-	0.08		-	-
Cloudy Bay Lagoon	Wave dominated	Near pristine	B	Low	0.86	6.11	13.51	2.22	4.10
Cockle Creek	Wave dominated	Near pristine	C	Medium	0.53	0.19	4.62	-	2.00
Crookes	Tide dominated	Modified	D	Low	0.21	1.30	2.37	-	1.01
D'Entrecasteaux	Tide dominated	No assessment	D	Medium	0.44	0.03	24.60	-	6.07
Denison	Wave dominated	Modified	B	Low	1.83	0.03	3.22	-	1.48
Derwent	Tide dominated	Extensively modified	C	Low	1.01	195.75	130.26	5.77	46.72
Earlham Lagoon	Tide dominated	Modified	C	Low	2.61	0.83	6.78	0.42	2.28
Esperance	Wave dominated	Largely unmodified	C	Low	0.24	2.23	28.00	3.70	8.99
Freney Lagoon	Wave dominated	Near pristine	B	High	0.73	0.69	5.75	0.80	1.85
Freshwater Lgn	Wave dominated	Near pristine	B	High	0.59	0.25	6.00	-	2.60
Garden Island	Wave dominated	Modified	D	Low	0.32	0.05	1.67	-	0.74
Grindstone	Wave dominated	Modified	B	Low	1.83	0.19	3.22	-	1.48
Huon	Tide dominated	Modified	C	Low	2.28	68.15	135.30	4.95	48.88
Lisdillon	Wave dominated	Modified	C	Low	3.19	0.26	5.10	0.30	2.17
Little Swanport	Wave dominated	Modified	C	Low	0.18	6.01	31.30	0.82	8.11
Louisa Creek	Wave dominated	Near pristine	C	High	0.43	0.02	4.72	-	2.39
Louisa River	Wave dominated	Near pristine	B	High	0.16	0.08	0.21	-	3.88
Lune	Wave dominated	Largely unmodified	B	Low	0.21	4.57	23.60	2.45	7.38
Meredith	River and wave dominated	Modified	C	Low	3.37	0.05	1.32	-	0.59
Moulting Lagoon	Wave dominated	Near pristine	D	Low	2.4	40.74	-	-	-
New River Lagoon	Wave dominated	Near pristine	A	High	0.95	11.95	29.90	2.57	12.72
Norfolk Bay	-	-	-	-	-	-	-	-	-
North West Bay	Tide dominated	Extensively modified	E	Low	0.15	0.32	25.83	4.66	8.59
Oyster Cove	-	-	-	-	-	-	-	-	-
Payne Bay	Tide dominated	Near pristine	A	High	0.04	43.62	69.41	-	19.75
Pipeclay Lagoon	Wave dominated	Modified	D	Low	0.25	5.31	13.80	3.70	2.60
Pirates Bay	-	-	-	-	-	-	-	-	-
Pitt Water	Wave dominated	Extensively modified	D	Low	0.07	46.12	80.39	4.38	23.64
Port Arthur	Tide dominated	-	-	-	0.04	0.04	34.94	3.48	9.80
Port Cygnet	Tide dominated	Modified	D	Low	0.3	14.34	24.10	-	7.00
Prosser	Wave dominated	Modified	D	Low	0.59	0.38	6.00	-	2.60
Saltwater Lagoon	Wave dominated	Near pristine	C	Low	-	0.21	-	-	-
South Cape Rivulet	Wave dominated	Near pristine	B	High	0.88	0.02	0.96	-	0.45
Southport Lagoon	Wave dominated	Near pristine	A	Medium	0.39	10.51	20.90	5.19	3.97
Spring Bay	Tide dominated	Modified	D	Low	2.87	5.30	16.68	1.69	5.63
Stony River	Wave dominated	Modified	C	Low	-	0.01	-	-	-

* From Edgar *et al.* 1999

Existing data and information

Current management and monitoring programs

Current programs and practices

Water quality information is collected by a variety of organisations (e.g. Australian, State and Local Government, industry and community groups) for a number of different reasons (e.g. public health, conservation and resource management). As part of this project we have collated existing data and identified priority areas for further monitoring. A summary of the current water quality monitoring programs in the NRM South Region is provided in Appendix 3.

National programs

The Australian and New Zealand Environment Conservation Council (ANZECC) have provided a forum for member governments to develop coordinated policies about national and international environment and conservation issues. The National Water Quality Management Strategy (NWQMS) was developed by ANZECC and introduced by the Australian, State and Territory Governments to sustainably manage the nation's water bodies. The main policy objective of the NWQMS is, "to achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development".

The Natural Heritage Trust (NHT) was set up by the Australian Government in 1997 to help restore and conserve Australia's environment and natural resources by allocating funding to community groups and organisations for natural resource management projects. The NHT provides funding for environmental activities (e.g. coastal rehabilitation) at a community (through the Australian Government Envirofund), regional and National/State level.

OzEstuaries is a database developed by the Coastal CRC/Geoscience Australia that collates data and information about Australian estuaries and coastal waterways. OzEstuaries represents the collaborative efforts of coastal scientists from a range of government agencies and universities and integrates data from the Australian Estuarine Database (AED; Digby *et al.* 1998) and new data collected during the National Land and Water Resources Audit (NLWRA). Coastal habitat extent and diversity data from around Australia was assessed during the NLWRA, which was used to differentiate coastal waterways on the basis of geomorphic classification and geomorphic characteristics (Smith *et al*. 2002).

State Government and Regional programs

The *State Coastal Policy 1996* was implemented by the State Government to conserve intrinsic assets, values and processes of the coastal area, and to ensure the sustainable use or development of the coastal area (this policy has been revised). One of the proposed outcomes of this policy was to maintain water quality in coastal and aquatic ecosystems, and support other values and uses, such as contact recreation, fishing and aquaculture.

The *State Policy on Water Quality Management 1997* (the Water Policy) was introduced in response to the National Water Quality Management Strategy. The Water Policy sets a framework for:

- determining Protected Environmental Values (PEVs), which have been set for the majority of catchments in the Southern. The PEVs are used as a basis for setting Water Quality Objectives (WQOs)
- setting Water Quality Guidelines (WQGs) and WQOs. WQGs are estimated levels of indicators that should be met in order to protect certain environmental values, while WQOs require more precise information and they are set for a specific body of water and should be met to achieve all PEVS (Environment Division, DTAE)
- establishing guides for the management of both point and diffuse sources of pollution (e.g. dairy effluent management, works in streams, road construction and maintenance, forestry management and soil management on agricultural land)

WQGs may draw on the ANZECC WQG and these are not necessarily a State defined level. WQOs however are set by the State using site specific infpromation through the PEV process. Protected Environmental Values for all surface waters are available on the DPIW website at http://www.dpiw.tas.gov.au/inter.nsf/WebPages/EGIL-53L3KY?open.

The different perceived values of estuaries and coastal waters has resulted in some conflict of resource usage (e.g. increasing opposition to the expansion of marine farming in Tasmania (Crawford 2003)). A process to identify the uses and values of catchments was begun in 2001 in order to reduce this conflict. Protected Environmental Values (PEVs) have been established for most surface waters, including estuaries in the Region. These were drafted by DPIW after consultation with stakeholders to identify the current uses and values of catchments in estuaries. The PEVs are summarised in Appendix 2. The PEVs are:

A. Protection of Aquatic Ecosystems
    i. Pristine or nearly pristine ecosystems;
    ii. Modified (not pristine) ecosystems:
        a. from which edible fish, crustacea and shellfish are harvested, or
        b. from which edible fish, crustacea and shellfish are not harvested.
B. Recreational Water Quality and Aesthetics
    i. Primary contact water quality
    ii. Secondary contact water quality
    iii. Aesthetics water quality
C. Raw Water for Drinking Water Supply (applicable to estuaries only in how it affects water supply)
D. Agricultural Water Use (applicable to estuaries only in how it affects water supply)

E. Industrial Water Supply

Although important in the process of determining water quality objectives and targets, the PEVs for coastal waters, estuaries and catchments in the NRM South Region are relatively uniform and thus have limited value for selecting key locations for monitoring. In general, the locations were considered to be modified (not pristine) ecosystems from which edible fish, crustacea and shellfish are harvested and were valued for their primary contact, secondary contact and aesthetic water quality. Some estuaries were valued for their water supply to industry (mostly aquaculture/marine farming zones).

The majority of State-level water quality monitoring focuses on freshwater systems (e.g. Fuller & Katona 1993, Fuller 2000) and catchments (e.g. DPIWE 2002, DPIWE 2005). Existing catchment and natural resource management plans include: the Derwent Catchment Natural Resource Management Plan, three Hobart Water Catchment Management Plans, the Huon Valley Draft Natural Resource Management Strategy, the Coal River Catchment Management Strategy, and the Little Swanport Catchment Management Plan. All of these plans include sections on water quality management.

The Department of Primary Industries and Water (DPIW) manages a number of programs that monitor water quality, the majority of which are freshwater- or catchment-based programs. However, these projects can be used to initiate the development of catchment-scale programs and priorities. DPIW monitoring information also feeds into NRM Monitoring and Evaluation indicators and NRM regional strategies, Tasmania Together Benchmark process, and SoE reporting (pers comm. Kate Wilson). The Department of Tourism, Arts and the Environment (DTAE) now hold the Environment portfolio for the State Government (it was previously held in DPIWE). As such, the Environment division coordinate and manage activities such as State of the Derwent (and other SoE reporting), stormwater management and management of water quality data such as sewerage treatment plant and industry data (pers comm. Ruth Eriksen). Some specific State Government examples include:

- Survey of PCBs in Tasmanian Water Catchments: Preliminary report on a survey of trout, eels and sediments for PCBs, DDT, Heptacholor and heavy metals in Tasmanian water catchments 1999 - 2000
- Emission Limit Guidelines: Guidelines for common activities which are likely to give rise to "point source" discharges of pollutants to surface waters
- State of the Derwent: Review of pollution sources, loads and environmental quality data for the Derwent Estuary (south-eastern Tasmania, Australia) from 1997-2003
- Stormwater Management Plans (e.g. Derwent Estuary: This model stormwater management plan focuses on cleaning up stormwater pollution flowing into urban creeks and the Derwent estuary)
- Environmental Impact Statements and development plans (e.g. Huon River and Port Esperance Marine Farming)
- Marine Farming Management Plans (e.g. Pitt Water)
- Water Management Plans (e.g. Little Swanport)

The DPIW *Water Quality Baseline Monitoring Program* collects and collates information from the *Statewide baseline monitoring network* (pers comm. Kate Wilson). The Program produces Waterways Monitoring Reports that are published annually, and provide information on a catchment basis but do not include estuaries. This program collects data on streamflow, water quality and riverine health to provide current data to water management agencies, the NRM regions and locally focussed catchment groups that monitor Tasmanian waterways or have an interest in water information. State of Rivers reports (DPIW) are a compilation of data from routine monitoring and investigative studies designed to describe the condition of water quality, hydrology, river habitat and riverine health at a catchment scale.

SMEC Victoria (Snowy Mountains Engineering Corporation) and Thiess Environmental Services prepared a Water Quality Monitoring Strategy for Tasmanian freshwater and catchments on behalf of DPIWE in 2000. The objectives of this project were to identify gaps in water quality monitoring through stakeholder consultation and develop a Statewide Backbone Water Quality Monitoring Program supported by existing operational and community programs. This project produced a metadatabase of water quality monitoring activities in Tasmania, which has been revised and incorporated in Appendix 3. The implementation of *The Tasmanian Surface Water Quality Monitoring Strategy* by DPIW has resulted in the extension and establishment of the State's baseline monitoring network and *Water Quality Baseline Monitoring Program* (pers comm. Kate Wilson).

The DPIW Pesticide Monitoring in Water Catchments Program monitors some Tasmanian water catchments for a range of herbicides and other pesticides. The baseline monitoring program measures pesticide levels on a quarterly basis in rivers and streams at a number of testing station locations across Tasmania. The pesticides monitored include common agricultural and forestry pesticides and pesticides with high toxicity, or high mobility in the environment. The flood monitoring program measures pesticide levels in water samples collected during flood events (e.g. Esperance and Little Swanport Rivers). The results are collated and published on the DPIW website (www.dpiw.tas.gov.au).

The DPIW Water Quality Initiative (pers comm. Sven Myer) uses a CSIRO Pesticide model called Pesticide Impact Rating Index (PIRI) and validates it for Tasmanian conditions. This involves examining pesticide sampling and environmental conditions on forestry companies databases and conducting a pesticide usage audit across Tasmania to find out what pesticides are used in what catchments and on what crops and conducting research on pesticide environmental fate in the Tasmanian environment (such as sorption/desorption rates, leaching effects etc). The end product will be a free model that can be used by all companies as a risk assessment tool to prevent offsite movement of pesticides into waterways. There will be limited field sampling at the end of the program as a final test to ground-truth the PIRI model. The program is solely freshwater / catchment based. This project runs from May 2006 until the end of April 2008.

The Conservation of Freshwater Ecosystem Values (CFEV) Project, developed by DPIW as part of the Water Development Plan for Tasmania, aims to increase industry and community confidence that high priority freshwater values are appropriately considered in

the development and management of the State's water resources. A key output of the CFEV Project is a database based on Comprehensive, Adequate and Representative (CAR) reserve-design principles that can be used as a planning and information tool. The CFEV Project examined all freshwater-dependant ecosystems, including saltmarshes and estuaries. Across Tasmania, 113 estuaries were assessed according to their classification (biophysical classes), condition (Naturalness score), special values (e.g. important and/or threatened species, communities or habitats), land tenure security (National Park, Crown land, private land etc.) and conservation value. However, the data available on estuaries were limited, and significantly less that that available for some of the other ecosystem themes (e.g. rivers). The information from the CFEV database for estuaries should be evaluated with this in mind until the database is updated with more recent estuarine information.

This information was used to produce a hierarchy of conservation management priorities using the criteria of Naturalness, Representativeness and Distinctiveness (pers. comm. Danielle Hardie, DPIW). Rarer biophysical classes of each ecosystem theme with a preference for those with a higher Naturalness score were ranked as having a higher conservation management priority.' The CFEV desktop analysis used existing data and/or modelled outputs to develop various data sets (CFEV 2006):

1. Using selected categories/values from already existing data sets (e.g. TasVeg, GTSpot);
2. Using point data collected through other programs (e.g. Edgar *et al.* 1999) and applying mapping rules or statistical modelling to attribute values to all spatial units; and
3. By modifying or updating existing data sets to suit the CFEV objectives (e.g. IBRA tree assemblage map).

The CFEV assessment produced two conservation value outputs:

1. Representative Conservation Value (RCV)
    a. a measure of relative importance of ecosystem features based on their representation of biophysical classes and condition.
    b. at least one of every biophysical class (and the best representative example) is selected within the top selection band (A)
2. Integrated Conservation Value (ICV)
    a. considers special values (e.g. threatened species, threatened communities, migratory birds, geomorphology).

This then provides the basis for developing conservation management priorities, and gives strategic targets from funding, management and on-ground works.

Hydro Tasmania undertakes a number of programs and initiatives in relation to its operations, guided by its Aquatic Environmental Policy (e.g. macroinvertebrate monitoring; Uytendaal 2004). Hydro Tasmania has ~16 water quality and quantity monitoring stations within the Southern NRM Region. Hydro-Consulting has been funded by NRM South (2006) to establish surface water quality baselines to set trigger levels for Resource Condition Targets. The program, *Establishing Surface Water Quality Baselines to Set Trigger Levels for Resource Condition Targets*, is linked to this estuarine/coastal

water quality framework (in prep). These projects will review water quality monitoring in the Region with the aim of establishing an integrated water quality monitoring framework.

The Derwent Estuary Program (DEP) is a regional partnership between Councils (Brighton, Clarence, Derwent Valley, Glenorchy, Hobart and Kingborough), State and Australian Government, commercial and industrial enterprises (Hobart Water, Tasmanian Ports Corporation, Norske Skog Boyer and Zinifex Hobart Smelter), and community groups. The DEP was established in 1999 and has been nationally recognised for coordinating initiatives to reduce water pollution, conserve habitats and species, monitor estuarine health and promote greater use and enjoyment of the Derwent Estuary foreshore. The DEP conduct monthly sampling at 28 sites throughout the estuary as part of the Ambient Water Quality monitoring program. The DEP monitor a wide range of parameters, but are moving to stormwater focused/event based sampling (pers comm. Ruth Eriksen). The DEP also coordinate the Recreational Water Quality monitoring program for the 6 "Derwent" councils, which runs from November through March. Sampling for enterococci and other environmental parameters is conducted on a weekly basis at 40 sites throughout the estuary (pers comm. Ruth Eriksen).

Some additional studies conducted by DEP/Environment Division are the Coastal Catchments initiative Water Quality Improvement Plan for the Derwent, which included the incorporation of the Ambient Water Quality Program data into a hydrodynamic and toxicant model developed by CSIRO Marine Labs. Current monitoring includes nutrient data for incorporation into the development of a biogeochemical model for the estuary. Zinifex and DEP work collaboratively to monitor shellfish, water and sediment quality throughout the Derwent, and Norske Skog have done considerable work on water quality in the upper estuary. Both these industries undertake substantial water quality monitoring in the estuary (much of it through DEP Partnership Agreements) (pers comm. Ruth Eriksen).

The Department of Health and Human Services (DHHS) manages the Tasmanian Shellfish Quality Assurance Program (TSQAP) under the *Public Health Act 1997* and the *Food Hygiene Act 1998*. It is funded by shellfish growers and the State government. TSQAP monitors water quality in shellfish growing areas and the public health status of shellfish on marine farms, to determine the safety of farmed shellfish for human consumption. In addition to water temperature, salinity and faecal coliforms, TSQAP monitor pathogenic micro-organisms, algal biotoxins and hazardous chemicals from agricultural and industrial sources in areas leased for shellfish production. Heavy metals and *E. coli* in oyster meat are monitored much less frequently. TSQAP has collected data on water quality from many locations in NRM South (Figure 3).

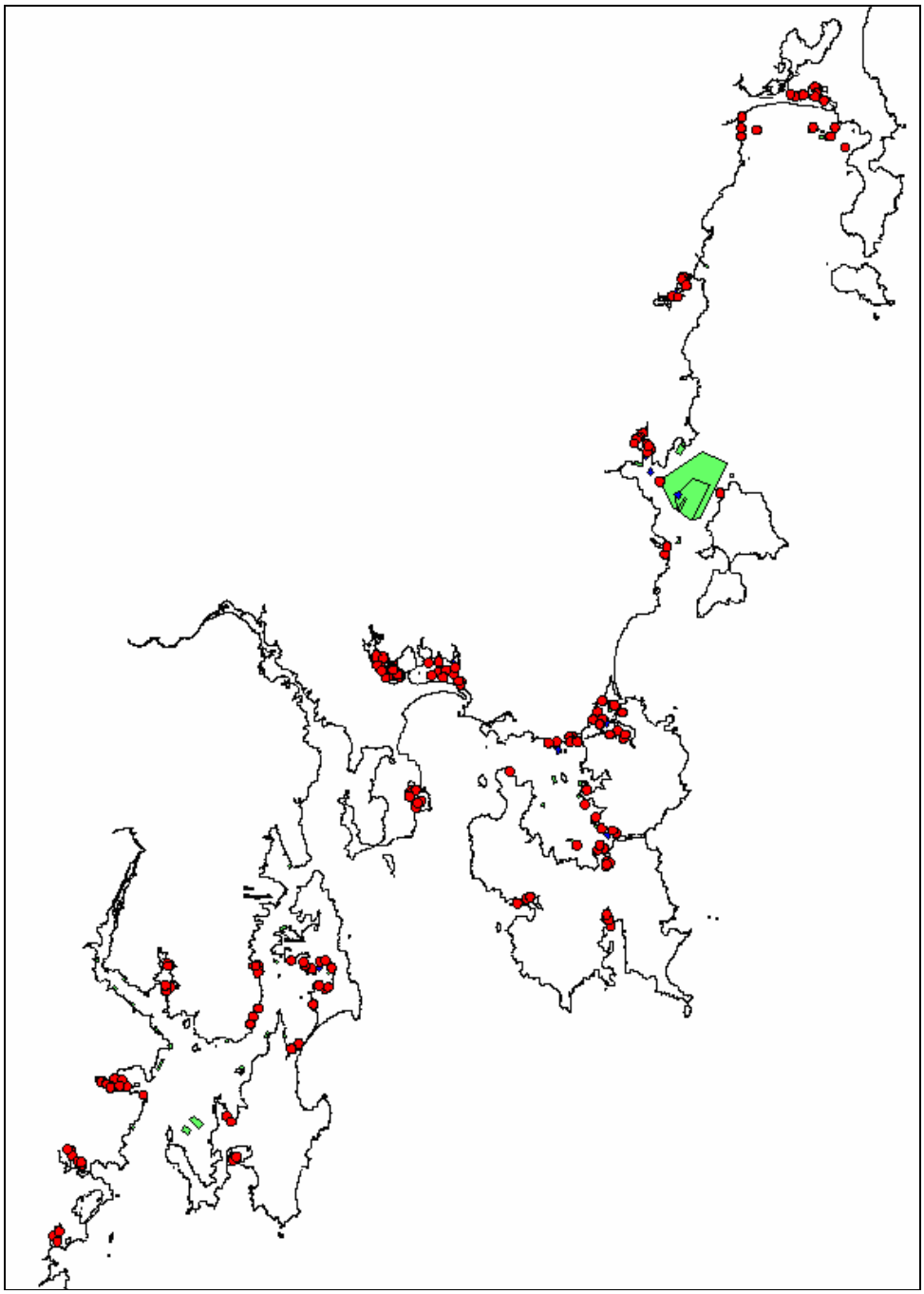

Figure 3. Tasmanian Shelfish Quality Assurance Program (TSQAP, Department of Health and Human Services) monitoring locations in NRM South.

Marine farming is an important rural industry in coastal bays and estuaries of southern Tasmania. The two main species cultured are the Pacific oyster (*Crassostrea gigas*) and the Atlantic salmon (*Salmo salar*) but other species farmed commercially in Tasmania include abalone, scallops and mussels, rock lobsters, seahorses and trout. The marine farming industry is regulated by DPIW under the *Living Marine Resources Management Act 1995* and the *Marine Farming Planning Act 1995*. This legislation was introduced to assist the development of aquaculture, and this includes requirements for environmental management such as baseline assessments and routine monitoring of leases (Crawford 2003). The majority of aquaculture activities occur in sheltered estuaries and coastal waters. There are 147 shellfish farms and 42 salmonid farms across the State, the majority of which are located in south eastern Tasmania (Table 4).

Table 4: Marine farming regions in south east Tasmania (Crawford 2003).

Location	Number of leases	Total leased area	Percentage of plan area used
Huon River & Port Esperance	25	333 Ha	3.9%
D'Entrecasteaux Channel	46	742 Ha	1.86%
Trumpeter Bay	1	10 Ha	3.8%
Pipe Clay Lagoon	9	49 Ha	9.2%
Pitt Water	7	108 Ha	2.6%
Tasman Peninsula & Norfolk Bay	23	453 Ha	2.1%
Blackman Bay	7	235 Ha	8.7%
Great Oyster Bay & Mercury Passage	22	5489 Ha	3.95%

DPIW prepares marine farming development plans (MFDPs) for the major marine farming areas of the State, which are reviewed every 10 years (pers comm. Colin Shepherd). All finfish marine farming leases within marine farming development plan areas conducted an environmental monitoring program from 1997-2002, including underwater video surveys and benthic sampling at finfish leases and research permit sites (Woods *et al.* 2004). This monitoring regime aimed to monitor compliance with management controls specific to benthic impacts and to assist in the development of an adaptive management based environmental monitoring system. This monitoring has led to the compilation of a comprehensive, area-specific dataset, providing information on environmental conditions within marine farming lease areas, at 35 metre compliance sites and control sites.

A baseline environmental survey must be undertaken prior to the commencement of marine farming operations on areas where a new lease area is being established, when required as a condition of varying or expanding a lease area, or where a marine farming licence is varied to allow the farming of another species not addressed by the existing baseline survey for the lease. Data collected may include but is not limited to video assessment, sediment particle size analysis, organic carbon content of the sediment, redox potentials, water flow rates, current flows and composition of the benthic community.

The environmental data collected, together with information on farm based operations and the recommendations of TAFI (Crawford *et al.* 2002, Macleod *et al.* 2002), is currently being reviewed by DPIW. Until this review is finalised, benthic monitoring is managed on a site by site basis as determined by the DPIWE. Monitoring has been ongoing through annual video assessment, which is based on the Macleod and Forbes (2004) guide to the

assessment of sediment condition. Baseline monitoring (physiochemical and benthic fauna) is required for any new marine farm that is set up in a new farming area.

Parks and Wildlife Service Tasmania (DTAE) are responsible for reserves such as National Parks, WHAs, Conservation areas, State, Public and Nature Reserves, and Historic Sites. To fulfil the responsibilities associated with these reserves, the Parks and Wildlife Service produces and implements area-specific management plans such as the Southport Lagoon Management Plan. In 2006 Parks and Wildlife funded a baseline assessment of the lagoon, including habitat mapping, assessment of seagrass, rocky reef flora and fauna, a survery of benthic invertebrates in soft sediments and a survey for rare and endangered species, in particular the seastar *Patriella vivipara.*

Mineral Resources Tasmania is the custodian for groundwater data (e.g. total dissolved solids, salinity), publications and reports – which is provided to MRT by drilling companies under the *Water Management Act 1999* and through their own monitoring of some bore sites (11 in NRM South) twice annually. Data is stored in the TIGER (Tasmanian Information on Geoscience and Exploration Resources) database and publications and borehole information are available online (www.mrt.tas.gov.au).

In addition to State Government roles, there is a regional system that operates under the *Tasmanian Natural Resource Management Act (2002)*. In Tasmania, there are three regional committees, which are responsible for the development and implementation of a NRM strategy for their region. The Southern Regional NRM Committee has developed developing the Southern regional plan, in consultation with the local community. This plan is based on a 'whole of region' approach and aims to address significant natural resource management issues – incorporating social, environmental and economic aspects.

The Southern NRM Strategy contains three sets of targets, consistent with the *National Framework for Standards and Targets*: Aspirational Targets (long-term, with a ~50 year timeframe), Resource Condition targets (10-20 year timeframe) and Management Action Targets (less than 5 year timeframe). Currently, there are insufficient baseline data to allow most Resource Condition Targets to be set with confidence.

Local Government

Bacteriological (enterococci) monitoring and reporting is required by all councils under the *Public Health Act 1997*. This is co-ordinated by the DHHS and ensures that recreational and potable water quality is monitored, and that the public is advised of areas unsuitable for swimming or water unfit for drinking. Recreational uses vary slightly across the region, but generally the waters are used for boating, swimming, fishing, snorkeling, surfing, and water skiing. Other environmental water quality monitoring is not required by law; however analyses of other physical and chemical parameters can provide significant information for councils.

In some instances councils provide financial and facilitatory assistance to community groups and in doing so help members to develop a deeper commitment to local area management. Local governments are also a potential user of community-sourced data, as

this data can be used for strategic planning, environmental monitoring and reporting purposes (Zeller *et al*. 2001).

Various water quality programs are coordinated by councils – these are summarised in the following sections (see DEP reports for information on the municipalities responsible for water quality monitoring in the Derwent Estuary www.derwentestuary.com.au).

Huon Valley Council

There are seven main estuaries and coastal waters within the Port Davey Catchment area in the Huon Valley Municipality (Figure 4). All seven of these are very remote and located in the Tasmanian Wilderness World Heritage Area (WHA) in south west Tasmania. They are all classed as "near pristine" environments (Heap *et al.* 2001).

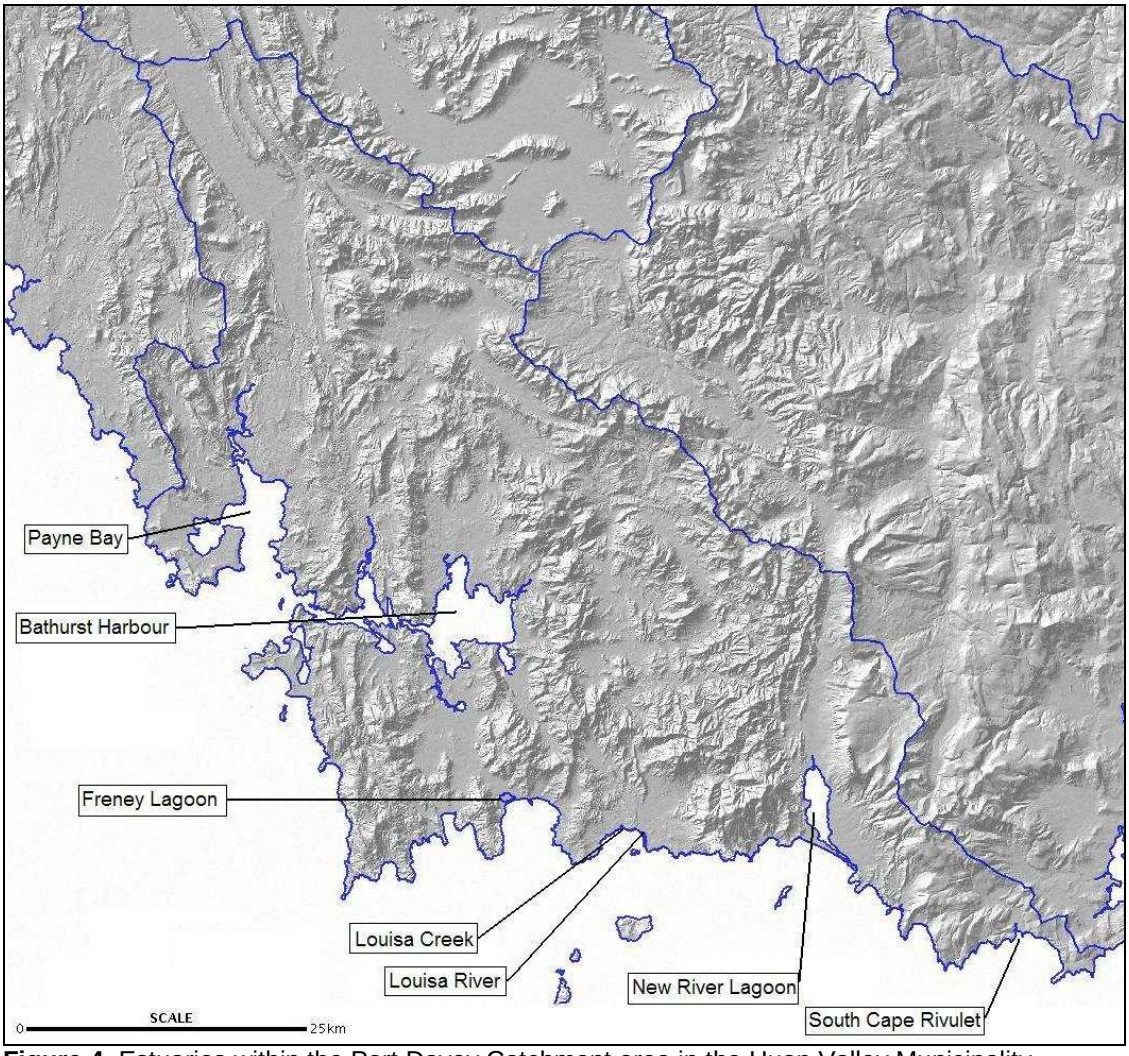

Figure 4. Estuaries within the Port Davey Catchment area in the Huon Valley Municipality.

There are ten main estuaries and coastal waters within the Huon Catchment area in the Huon Valley Municipality (Figure 5). The waters of the Huon Catchment are less remote than those of the Port Davey Catchment, particularly those within the Bruny marine bioregion (IMCRA Technical Group 1998). The estuaries within the Davey marine bioregion (Southport Lagoon, Lune River, D'Entrecasteaux River, Cockle Creek and Catamaran) are classed, based on geomorphical data, as "near pristine", while those in the Bruny marine bioregion are classed as "largely unmodified" (Esperance River) or "modified" (Crookes Rivulet, Huon, Port Cygnet and Garden Island) (Heap *et al.* 2001).

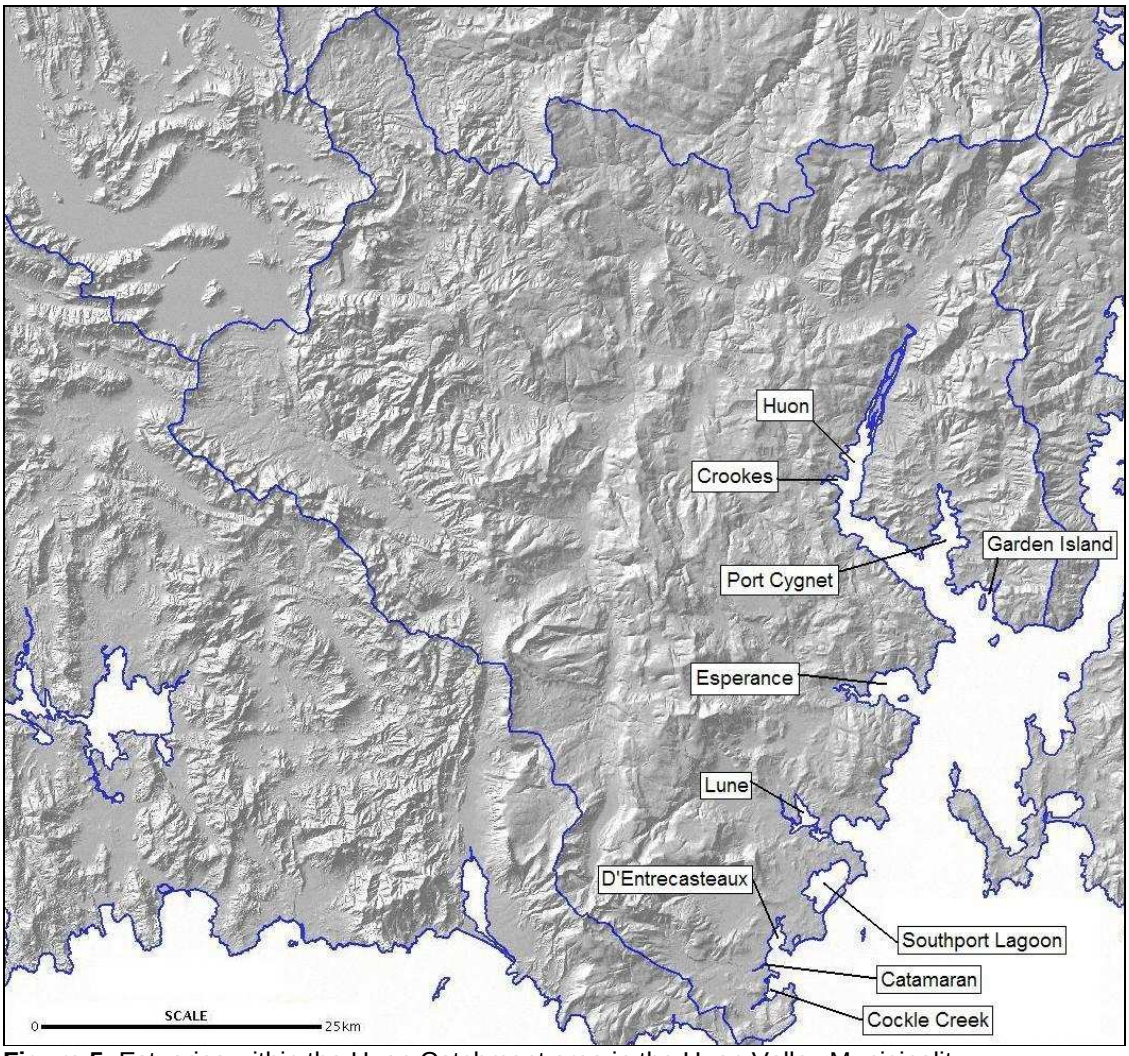

Figure 5. Estuaries within the Huon Catchment area in the Huon Valley Municipality.

Huon Valley Council monitors potable water in the municipality on a fortnightly basis and two recreational sites on a weekly basis between November and March each year (pers comm. Helena Bobbi). Monitoring and sampling is also undertaken at the point of outflow from the five Sewage Treatment Plants (STP) in the municipality (Ranelagh, Cygnet, Geeveston, Dover, and Southport). Drinking water and recreational water reports are prepared annually and submitted to the DHHS.

The Huon Healthy Rivers Program has been integrated in the Huon Valley's NRM program (pers comm. Holly Hanson). This program provides a network for Care groups and encourages them to consider including water quality monitoring as part of their environmental projects. Waterwatch groups have monitored a number of sites in the Huon River and its tributaries) but have mostly focused on freshwater. The estuaries have been monitored very little in comparison (there has been some monitoring by a community group in Port Cygnet). Waterwatch monitoring has been less consistent in recent years, however the Huon Valley NRM program is currently examining ways to develop and support Waterwatch monitoring in the municipality (pers comm. Holly Hanson). support monitoring in the municipality (pers comm. Holly Hanson).

Kingborough Council

There are four main estuaries and coastal waters within the Derwent Estuary-Bruny Catchment area in the Kingborough Municipality (Figure 6).

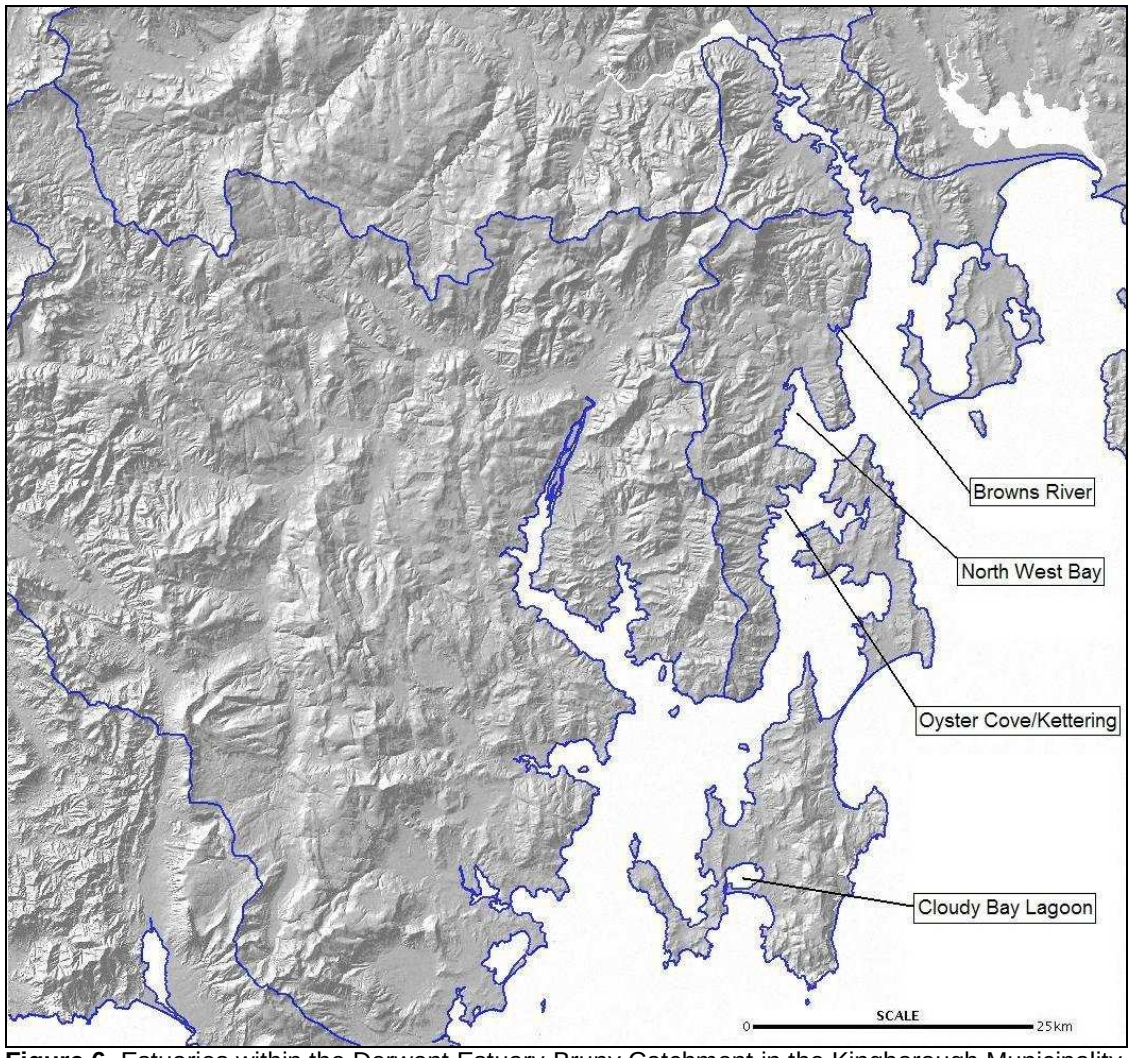

Figure 6. Estuaries within the Derwent Estuary-Bruny Catchment in the Kingborough Municipality.

Kingborough Council carries out several programs to monitor water quality (pers comm. Abyilene Dobson). Recreational water quality (bacteriological) is monitored during summer (November-March) within the Derwent Estuary (7 sites) on a weekly basis and the Channel/Bruny Island on a monthly basis. More extensive monitoring (bacteriological, pH, turbidity, conductivity, DO, nutrients, etc) is undertaken at the six STPs, the pollution abatement ponds (and wetlands), and at three dam sites in the municipality (see Table 5).

There are two focus areas for coastal/catchment monitoring in the municipality: Browns River and North West Bay River.

Browns River in Kingston flows to the coast via a small estuary in the popular recreational area of Kingston Beach. However, the estuarine waters have been identified as faecally contaminated and unsafe for primary contact, mainly due to contamination of the Browns River tributaries, especially Kingston Rivulet. The Council and NHT funded the construction of the Kingston Pollution Abatement Ponds and Wetlands to treat contaminated runoff and produce a measurable improvement in water quality in the recreational waters of Browns River estuary and Kingston Beach (MEMS 1998). The wetlands included modification of Kingston Rivulet, Whitewater Creek and Browns River. Ongoing, 6-monthly monitoring of the wetlands and Browns River estuary is outsourced by Kingborough council and includes monitoring bacteriological levels, nutrients (ammonia, phosphorous, nitrate, nitrite), turbidity, DO, pH and conductivity (MEMS 2000). Results indicate that the wetland system is effective in achieving the proposed goals to decrease the level and frequency of contamination (faecal, bacteria, particulates, litter and nutrients), improve oxygenation of passing waters, improve faunal habitat and to provide an aesthetically pleasing recreation and education facility (MEMS 2003). Although improvements have been reported, intermittent faecal contamination of the Browns River and estuary remains an ongoing issue, however this is largely related to rainfall events (MEMS 2003).

North West Bay is a significant area for the community (various recreational values) and industry (e.g. salmon aquaculture). The North West Bay Program includes a number of ongoing and short-term components, including:

- assessment and monitoring of nutrients and habitats in North West Bay
- restoration programs (bank stabilisation/revegetation to reduce erosion and damage due to high flow/flooding)
- assessment and monitoring of North West Bay River and its tributaries (freshwater monitoring, see Table 5)

Kingborough Council have expressed a keen desire to participate in a water quality monitoring program for North West Bay (John Doole, pers. com.)

Table 5. Kingborough Water Quality Monitoring Summary (pers comm. Abyilene Dobson).

PROGRAM	PARAMETERS	FREQUENCY OF MONITORING	NUMBER OF SAMPLING SITES	GENERAL AREA SAMPLED	COMMENTS
Recreational Water	Enterococci	Weekly from Nov - March (Derwent Estuary)	Derwent Estuary: 7 sites	Refer Recreational Water Report	Recreational Water Report available
		Monthly from Nov – March (Channel sites)	Channel (incl Bruny Island):12 sites		
STPs	Thermotolerant coliforms	Monthly	6 STPs	Blackmans Bay STP	Annual report shortly available
	Enterococci		1 Wetland site	Electrona STP	
	TS		3 Dam sites	Howden STP	
	pH			Margate STP	
	NH_3N			Taroona STP	
	TN			Woodbridge STP	
	NN			Woodbridge Wetland	
	TP			Howden NWBGC Dam 01, 02, 03	
	BOD_5				
	Oil and Grease				
	Additional parameters for dam sites				
Kingston Wetlands	Thermotolerant coliforms	6-monthly (out-sourced)	7 Wetlands	Kingston Wetlands	Kingston Wetlands Report(s) available
	Enterococci		1 Browns River mouth	1 sample at Browns River mouth	
	pH/mV (on-site)				
	DO/% (on-site)				
	Turbidity (on-site)				
	Conductivity (on-site)				
	Nutrients at 4 sites: Ammonia, phosphorous, nitrate, nitrite				
Kettering	Thermotolerant coliforms	Monthly	6 sites	Kettering foreshore/marina	
	Enterococci				
	E.coli				
River Nutrients	Ammonia	Quarterly (seasonal)	10 sites	Browns River	
	Nitrate			Coffee Creek	
	Nitrite			Snug River	
	Phosphorous			Whitewater Creek	
				Margate Rivulet	
				Kettering Creek	
				Kingston Rivulet	
				Gemalla Creek	
North West Bay River	Thermotolerant coliforms	2-monthly	10 sites	North West Bay River	Sampling undertaken by a resident (environmental scientist)
	Enterococci			Allens Rivulet	
	TSS (on-site)			Cooke Rivulet	
	pH (on-site)			Thompson Creek	
	Conductivity (on-site)			Longley & Betts Rd	
				Platypus Creek	

Clarence City Council

Clarence City Council (CCC) collects recreational water quality data, as part of the Derwent Estuary Program, and as required by recreational water quality guidelines (pers comm. John Fawcett). All data is collected from an Environmental Health (Public Health

and Safety) point of view. There is currently no specific monitoring of the health or quality of marine environments by CCC.

At present, CCC collects recreational water quality data at Bellerive Beach, and 3 sites on Howrah Beach on a monthly basis through winter. During summer, CCC samples the same sites on a weekly basis, and in addition samples at Lauderdale Canal, Dorans Road (in Ralphs Bay) and at Opossum Bay. Samples are also taken from stormwater outfalls at some locations if flow is sufficient – for example stormwater lines at Howrah Beach are sampled after major rain events, following DEP guidelines. Samples are collected in sterile bottles and analysed for enterococci using the Enterolert test at the Public Health Lab. All data collected is forwarded to the DEP, and is collated along with other data collected by DEP partners. The DEP then uses this data to produce reports such as the State of the Derwent Report, and Derwent Report Cards (available on the DEP website).

Water quality is not sampled in Pipe Clay Lagoon and Pittwater by CCC, but it is sampled by TSQAP/commercial oyster growers. Data is monitored on a pass/fail basis, and is not collated by CCC. In the past, community Waterwatch programs have been run (mainly local creeks/rivulets) but due to a lack of community support and facilitation none are operational at present. Clarence City Council is in the process of reviewing all sampling undertaken by Council, and the way in which the data is used. As part of this review process CCC is considering the need for additional sampling locations.

Pitt Water is a very large, shallow and complex estuarine system located between the Clarence City Council and Sorell Council (Figure 7). Although it is extensively modified, the area is a significant habitat for rare and threatened species. Orielton Lagoon is an internationally recognised Ramsar wetland.

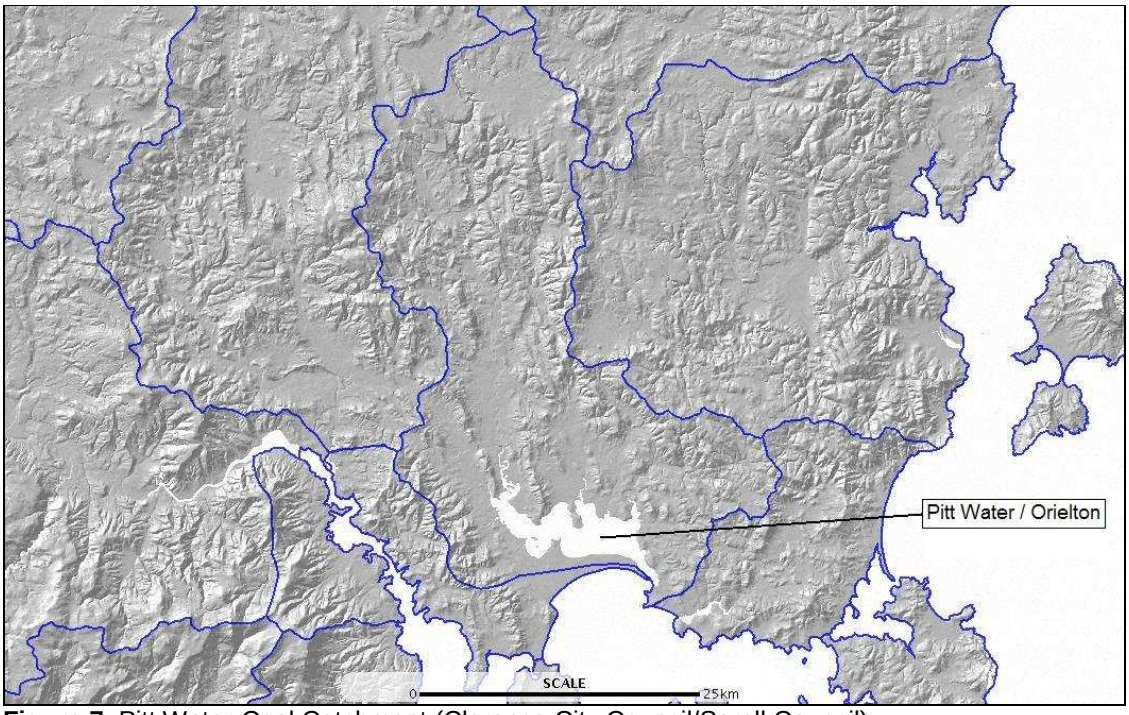

Figure 7. Pitt Water-Coal Catchment (Clarence City Council/Sorell Council).

Pipe Clay Lagoon (Figure 8) is a large estuary with substantial areas of oyster farming within the estuary and land clearing and urban development in and around the lagoon.

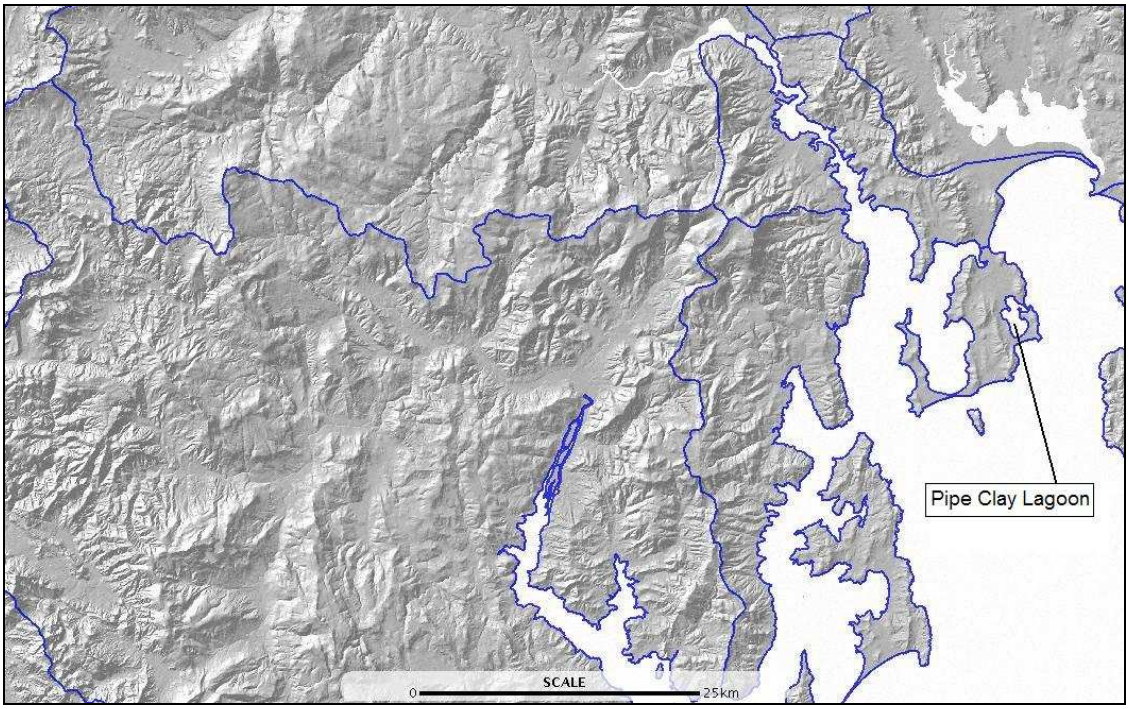

Figure 8. Pipeclay Lagoon (Clarence City Council).

Sorell Council

Sorell Council collects water quality information to fulfil its functions under the *Public Health Act 1997*. Weekly recreational water quality data (enterococci and rainfall) is collected during summer (mid-November to mid-March) at several sites: Primrose Sands Beach, Park Beach, Red Ochre Beach, Tigerhead Beach, Okines Beach and Jones Bay. This information is used for annual reports on water quality, which are publicly available (e.g. Mason 2006). The catchment areas of each of the recreational sampling sites contain significant numbers of septic tanks and other on-site waste water management systems. In periods of wet weather, stormwater systems or creeks may act as conduits, conveying pollutants to beach areas (Mason 2006).

Whilst each of the sampling sites met the recommended median and geometric mean enterococci levels, Red Ochre Beach, Tigerhead Beach and Okines Beach occasionally exceeded the 60-100 org/100 mL guidelines for enterococci (Mason 2006). Jones Bay is currently signposted as unsuitable for primary contact or shellfish consumption and it has been recommended that similar signage be provided at Red Ochre Beach due to intermittent and unpredictable faecal contamination (Mason 2006).

The Tasman Catchment crosses municipal boundaries (Sorell and Tasman Councils). There are five main coastal areas within the Tasman Catchment area (Figure 9), which are generally in a modified condition (Heap *et al.* 2001)

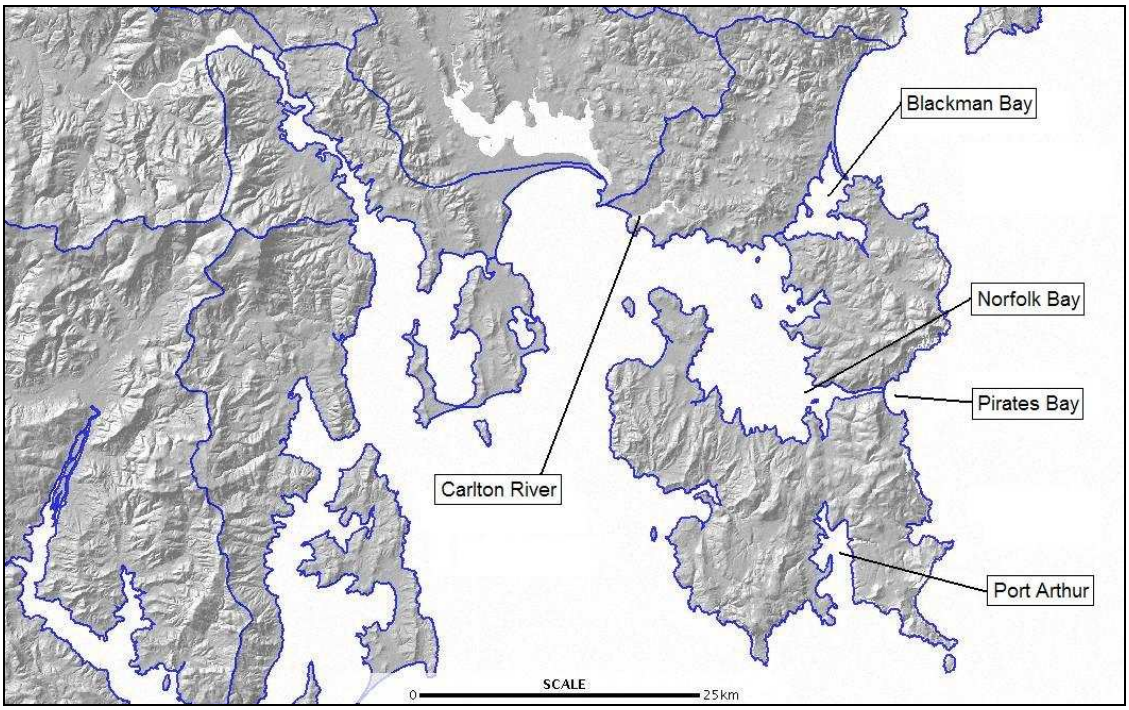

Figure 9. Estuaries of the Tasman Catchment.

Tasman Council

A Tasman Council recreational water quality monitoring program commenced in summer 2005. Previously, Tasman Council has not submitted annual recreational water reports to DHHS due to a lack of program/resources (during 2003-2004; DHHS 2005).

At this stage, town-water and sewerage services are not generally available within the municipality. The Council is currently investigating the feasibility of wastewater systems at Nubeena, White Beach and Port Arthur. Since septic tanks are the main component of human-waste management in the district, estuarine and coastal water quality monitoring should be an important consideration.

Glamorgan Spring Bay Council

There are three main catchments in the Glamorgan Spring Bay Municipality: the Little Swanport, Prosser and Swan-Apsley Catchments. The Prosser Catchment (Figure 10) drains into Mercury Passage (between Orford and Maria Island). There are four main estuaries and coastal waters within the Prosser Catchment area in the Glamorgan Spring Bay Municipality.

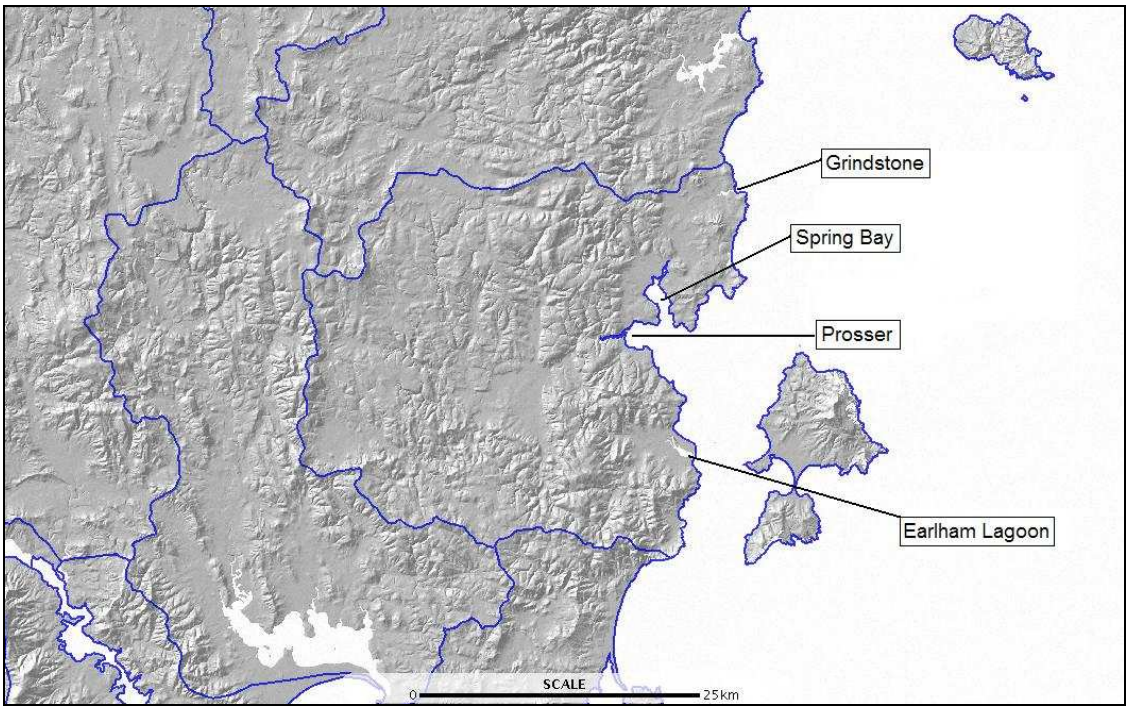

Figure 10. Estuaries of the Prosser Catchment (Glamorgan Spring Bay Council).

The Little Swanport Catchment (Figure 11) is drained by Little Swanport River (~60 km), which discharges into Great Oyster Bay via the Little Swanport estuary. There are three main estuaries and coastal waters within the Little Swanport Catchment area in the Glamorgan Spring Bay Municipality. They are of a modified condition (Heap *et al.* 2001).

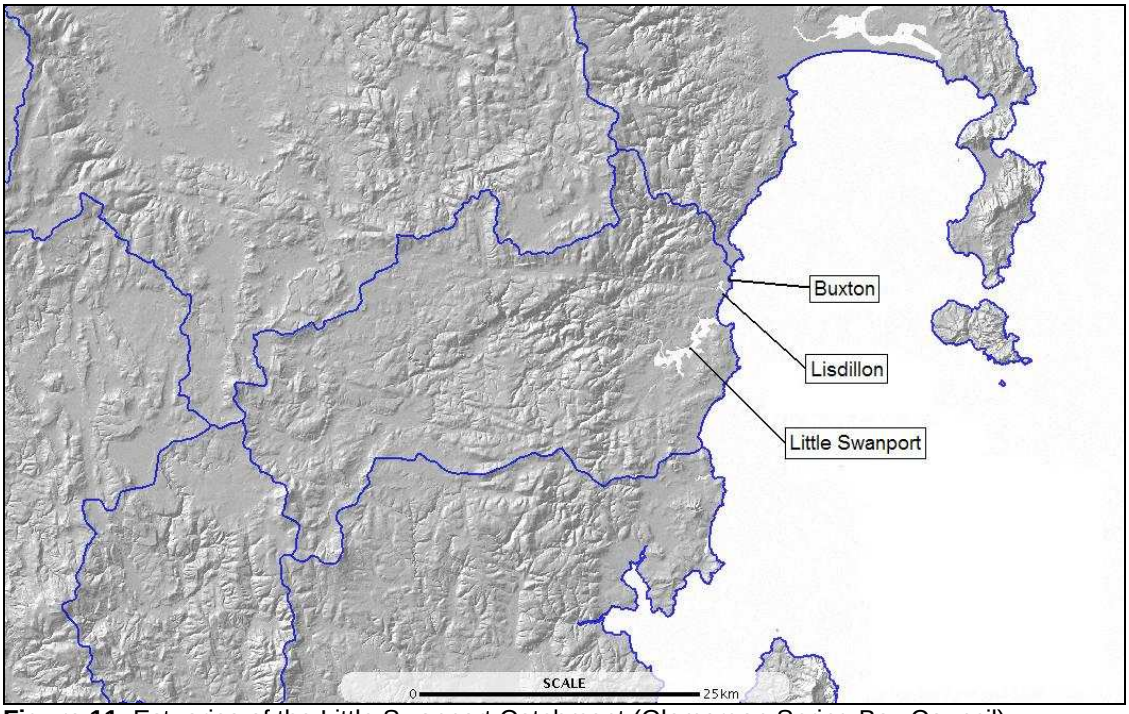

Figure 11. Estuaries of the Little Swanport Catchment (Glamorgan Spring Bay Council).

The Swan-Apsley Catchment (Figure 12) is so-named because it is dominated by the Swan and Apsley Rivers. There are seven main estuaries and coastal waters within the Swan-Apsley Catchment area in the Glamorgan Spring Bay Municipality, which are of a "near pristine" (Moulting, Bryans, Saltwater and Freshwater Lagoons), or "modified" (Denison, Meredith and Stony River estuaries) condition (Heap *et al.* 2001).

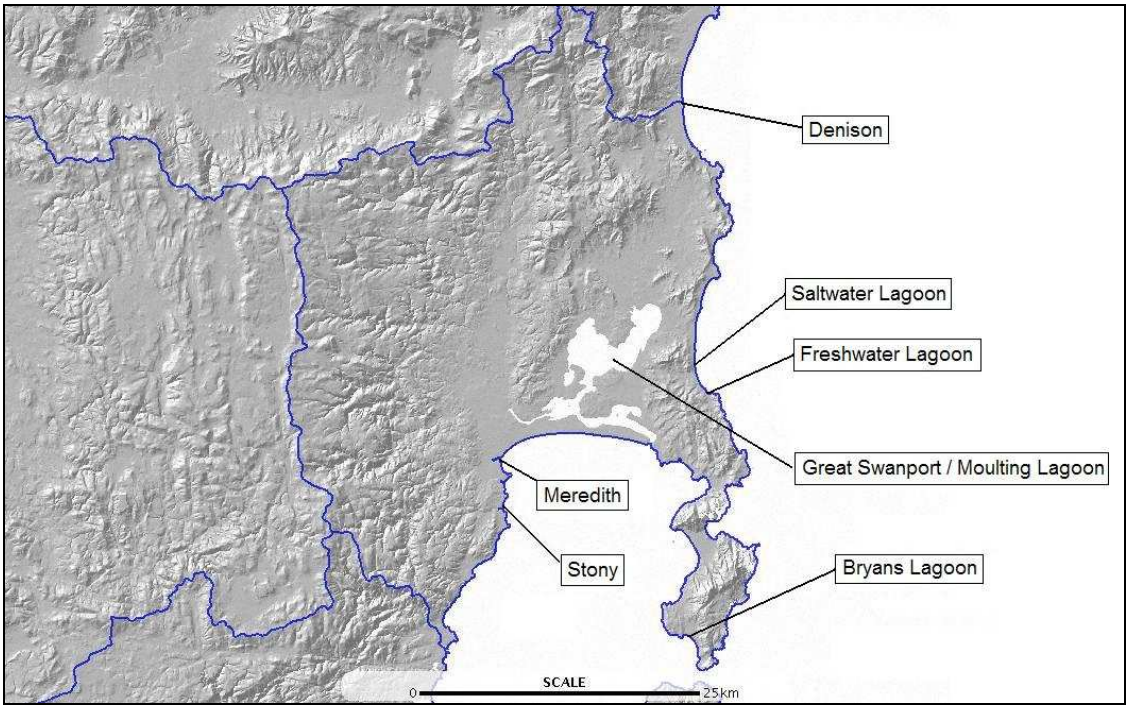

Figure 12. Estuaries of the Swan-Apsley Catchment (Glamorgan Spring Bay Council).

Recreational water quality monitoring is undertaken for water bodies within the Glamorgan Spring Bay Council area in accordance with the *Public Health Act 1997*. There are four STPs in the municipality: Orford on the road to Spring Beach, Triabunna on Freestone Point Rd, Swansea on Maria Street and Bicheno. Due to changing resource restraints, Recreational sites are selected for sampling according to an annual risk assessment. This means that each year the recreational water quality monitoring program varies in the location and number of sites examined. The methods used for sampling and reporting also vary over time. Glamorgan Spring Bay Council is currently reviewing their water quality monitoring. A summary of the program since 1999 is provided below (Table 6).

In the past, Glamorgan Spring Bay had an active Waterwatch Program, which was supported by Glamorgan Spring Bay Council (through the Environmental Health Officer/s and the Waterwatch Facilitator/Landcare Coordinator). This commenced in 1998 as a school-based program (e.g. Prosser River Estuary/Orford Primary School) and expanded in 2000 to include community Waterwatch groups: Coles Bay Waterwatch, Denison Catchment Waterwatch, Saltwater Creek Waterwatch and Dolphin Sands Groundwater Waterwatch (all of which have published monitoring plans). In more recent years, a Little Swanport Catchment group has developed a Waterwatch monitoring plan (2004).

Although some of these groups still exist, water quality monitoring has not been ongoing, or has changed to event-based monitoring (e.g. Coles Bay Waterwatch) due to the reduction in resources and facilitation.

Glamorgan Spring Bay Council is currently implementing a whole-of-ecosystem and whole-of-catchment management model through an NRM South funded project. The aim of this project is to build on the Little Swanport catchment management process to develop a model that can be applied to other Tasmanian catchments.

Table 6. Summary of the Glamorgan Spring Bay Council Recreational Water Quality Program (Total thermotolerant coliforms and enterococci).

Summer (year)	Collection months	Frequency of monitoring	Number of sampling sites	Sampling sites
2005/2006	Dec-Mar	Monthly (approx.)	6	Waubs Beach, Bicheno Muirs Beach, Coles Bay Jubilee Beach, Swansea East Shelly Beach, Orford Spring Beach, Orford Mayfield Beach, South of Swansea
2000/2001	Dec-Mar	Fortnightly (approx.)	4	Denison Rivulet, North of Bicheno Swan River, Colebrook Little Swanport River, Little Swanport Prosser River, Orford
1999/2000	Dec-Mar	Weekly	8	Denison Rivulet, North of Bicheno Waubs Beach, Bicheno Swanwick Beach, Swanwick Richardsons Beach, Coles Bay Jubilee Beach, Swansea Little Swanport River, Little Swanport Rapsins Beach, Orford Shelly Beach, Orford
1999	Jan-Mar	Weekly (approx.)	9	Denison Rivulet, North of Bicheno Waubs Beach, Bicheno Richardsons Beach, Coles Bay Jubilee Beach, Swansea Mayfield Beach, South of Swansea Saltworks Jetty, Little Swanport Spring Bay Causeway, Triabunna Rapsins Beach, Orford Spring Beach, Orford

Other Research

There are many published studies on estuarine and coastal water quality – most of which are short term projects or snap shots of specific areas. Some water quality information is also contained within management plans or Environmental Impact Statements. The main sources of this data and literature include TAFI (University of Tasmania), CSIRO and private consultancies.

TAFI and the University of Tasmania

Many studies published by TAFI are collaborative projects with councils and/or bodies such as NHT and NRM South. Some of these projects include:

- Estuarine health in Tasmania: water quality status and indicators (Murphy *et al.* 2003);
- Classification of Tasmanian estuaries and assessment of their conservation significance (Edgar *et al*. 1999, Edgar and Barrett 2000);
- Distribution of macroinvertebrates and fishes in Tasmanian estuaries (biogeography) (Edgar *et al*. 1999b)
- Ecological Status of the Derwent and Huon Estuaries (Macleod and Helidoniotis 2005)
- A survey of the water chemistry and distribution of zooplankton and phytoplankton in the Bathurst Harbour estuary (Edgar and Cresswell 1991);
- Assessment of physical and chemical parameters of estuaries (e.g. Jordan *et al*. 2002, Crawford and Mitchell 1999). These include Pitt Water, Little Swanport, and North West Bay
- Mapping estuarine and marine habitats: Seamap project (e.g. Barrett *et al.* 2001, Jordan *et al*. 2001, and Mount *et al*. 2005); and
- Monitoring Tasmanian inshore reef ecosystems and an assessment of the potential for volunteer monitoring programs (Barrett *et al*. 2002).

The Murphy *et al*. (2003) report provides a summary and assessment of water quality parameters from 22 estuaries around Tasmania – 8 of which are located in the NRM South Region (Table 7). The estuaries were chosen to reflect a range of physical estuarine groups and conservation significance. Estuaries were divided into zones to reflect the upper, middle and lower reaches of each estuary and two sampling sites were randomly selected within each zone. The parameters sampled included temperature, salinity, dissolved oxygen, turbidity, nutrients (NOx, PO_4 and SiO_4), chlorophyll and suspended solids. These were sampled at two monthly intervals and the baseline data were used to derive draft indicator levels.

As part of the Edgar *et al*. (1999) study, benthic macroinvertebrate fauna and physiochemical data (including temperature, turbidity, dissolved oxygen and salinity) were collected. Edgar *et al*. (1999) considered 39 estuaries in the NRM South Region. These data were incorporated into a much larger dataset that includes land and population information as well as previously existing biological and physical data, and was used to establish conservation significance of estuaries (see Table 3).

TAFI currently have a major project in the Little Swanport catchment investigating the importance of freshwater flows into the Little Swanport estuary and assessing the value of water to different uses in the catchment, including to agriculture, to aquaculture and to non-monetary ecosystem goods and services. Water quality data (temperature, salinity, turbidity, dissolved oxygen, chlorophyll a and nutrients were collected monthly at six sites in the estuary for 12 months in 2004/05. Fish community structure, zooplankton and phytoplankton were assessed at 4 sites every 1 -2 months. These data are available in the

final report to NHT (Crawford et al, 2005). More recently water quality data and zooplankton community composition have and are being collected every 2 weeks at one site in the lower estuary, fish community data every 4 months and phytoplankton are collected and analysed weekly by the oyster industry. The oyster farmers have installed three continuously monitoring temperature and a salinity data loggers in the estuary and one logger includes a probe for measuring dissolved oxygen.

Staff at TAFI have also been involved in the development of a water quality monitoring program in Moulting Lagoon near the Coombend vineyard which has rapidly expanded on the banks of the lagoon in 2005. Collection of baseline water quality data in Shelbourne Bay, including temperature, salinity, dissolved oxygen, turbidity, chlorophyll a, nutrients, invertebrate fauna and herbicides/pesticides was conducted by Aquenal Pty Ltd for the Coombend vineyard in conjunction with Parks and Wildlife, TAFI and DPIW Marine Resources. All parties and the Glamorgan Spring Bay Council have expressed a commitment to participate in a water quality monitoring program for the Moulting Lagoon area.

The effects of salmon farming on the environment of the Huon estuary and D'Entrecasteaux Channel have been monitored periodically by TAFI for 10 years as part of research to develop a cost-effective monitoring program for industry. Initially this research concentrated on monitoring sediment condition under and near cages of fish and at reference sites. This included benthic invertebrate fauna, video recording of the sea bed, redox and sulphide levels, stable isotopes of carbon and nitrogen and percentage organic matter in the sediment.

More recently this research has concentrated on investigating dispersal of soluble wastes from fish farms and whether this is impacting on the broader environment. Water quality of the Huon estuary was assessed by monitoring temperature, salinity, dissolved oxygen, turbidity, nutrients (nitrate, phosphate and ammonium), chlorophyll a and phytoplankton species composition monthly for 2 years in 2002/03 and at 12 sites in the D'Entrecasteaux Channel for 16 months, in conjunction with CSIRO.

Table 7. Average turbidity (NTU), chlorophyll a, NOx and PO4 concentrations (µg l-1) and yearly median value for each estuary, by bioregion and sampling event, July 1999 to June 2000 (Murphy *et al.* 2003).

Bioregion	Estuary	Parameter	JA99	SO99	ND99	JF00	MA00	MJ00	median (JA99-MJ00)
Freycinet	Great Swanport	Turbidity	1.7	1.5	1.6	1.5	1.4	1.8	1.4
		Chlorophyll a	0.3	0.4	0.1	0.9	0.6	1	0.5
		NOx	0	2	0	2	1	0	1
		PO4	6	3	2	4	5	2	3
	Meredith River	Turbidity	14.8	0.9	2.5	3.4	3.5	0.9	2.6
		Chlorophyll a	6	2.2	8.8	3.2	10	0.8	1.9
		NOx	124	6	1	56	3	6	6
		PO4	5	2	3	6	4	2	2
	Little Swanport	Turbidity	1.8	1.5	2.1	2.3	3.3	2.1	1.8
		Chlorophyll a	0.7	0.3	1.2	2.4	6.1	1.1	1.1
		NOx	3	1	0	0	0	2	0
		PO4	6	4	3	3	5	4	4
	Earlham Lagoon	Turbidity	3.7	1.8	2	2.1	3	0.9	2
		Chlorophyll a	0.9	0.2	0.5	0.8	0.6	0.1	0.4
		NOx	28	1	1	5	1	2	2
		PO4	9	6	6	5	6	6	6
Bruny	Browns River	Turbidity	56	1.8	3.9	5	5.1	3.1	3.2
		Chlorophyll a	2.4	0.7	2.5	7	9.2	4.7	2.6
		NOx	332	8	3	1	1	10	5
		PO4	8	14	25	13	42	17	16
	Cloudy Bay Lagoon	Turbidity	1.2	0.9	1.4	1.1	1	1.4	1
		Chlorophyll a	2.3	0.9	0.3	0.9	0.6	1	0.7
		NOx	7	4	0	2	1	13	1
		PO4	6	4	5	9	5	9	6
Davey	Catamaran River	Turbidity	3.1	1.2	1.2	2	1.1	2	1.5
		Chlorophyll a	0	0.6	0.5	0.1	0.1	0	0
		NOx	13	9	0	1	6	9	5
		PO4	4	7	5	5	5	4	5
	Cockle Creek	Turbidity	3.5	1	1.3	1.3	1.6	1.5	1.4
		Chlorophyll a	0.7	1.2	0.6	0.1	1.1	0.8	0.4
		NOx	22	5	1	1	1	7	2
		PO4	5	7	2	4	3	3	4

Draft (indicator levels)		low	medium	high	very high
Turbidity	NTU	0 to 4	4.1 to 10	10.1 to 20	> 20
Chlorophyll a	µg/L	0 to 2	2.1 to 5	5.1 to 10	> 10
NOx	µg/L	0 to 20	21 to 50	51 to 100	> 100
PO4	µg/L	0 to 5	6 to 15	16 to 30	> 30

CSIRO

The Huon Estuary has been the main focus of the CSIRO water quality monitoring work (Butler *et al.* 2001, CSIRO 2000). However, CSIRO has also looked at trace elements and organic matter in Bathurst Harbour (Mackey *et al.* 1996) and conducted a coastal and estuarine environmental baseline monitoring program in the D'Entrecasteaux Channel (in conjunction with TAFI).

The Huon Estuary Study (which includes Port Cygnet) was undertaken from 1996-1999 to investigate the interactions between human activity and natural processes and to determine the sources, distribution and cycling of nutrients (including links with algal blooms, effect on sediments of processes such as fish farming, and environmental quality). The project examined a large number of parameters including nutrients and water quality (dissolved oxygen, salinity, suspended particulate matter, nitrate, nitrite, ammonia, dissolved organic nitrogen, particulate nitrogen, total nitrogen, phosphate, dissolved organic phosphorus, total phosphorus, silicate, and conductivity), flow mechanisms (tide, currents, wind, river, rainfall), phytoplankton, optical absorption, sediments, fallowing of marine farms and contaminants (metals, pesticides).

Aquenal Pty Ltd

Aquenal is a private consultancy, which focuses on water-based assessments (e.g. risk and impact assessments, baseline surveys and compliance monitoring, introduced pest surveys, marine aquaculture operations, marine park biodiversity monitoring, and threatened species management). Some specific projects include:

- Port studies: Spring Bay and Derwent estuaries (Aquenal 2002)
- Foreshore mapping project: values and pressures in the Southern NRM Region (NHT funded)
- Oyster Cove Marina environmental and hydrological survey (in conjunction with Vantree Pty Ltd)
- Murphys Flat (Derwent River) aquatic communities survey and management plan (in cooperation with the DEP, Tasmanian Conservation Trust and Envirofund)
- Marine farm environmental surveys: environmental baseline surveys and follow-up monitoring surveys of over 60 marine farms in Tasmania. Farms surveyed include finfish, subtidal shellfish and intertidal shellfish operations in environments ranging from shallow, sheltered bays to open ocean coasts and deep river estuaries

Aquenal has developed environmental risk and impact assessments for coastal developments such as tourist facilities, marinas, wharves and bridges, industrial sites, effluent outfalls, thermal discharges, dams and pipelines. Some examples include:

- A paper mill on the Upper Derwent Estuary (biological aspects) - initial Environmental Risk Assessment and follow-up investigations
- A tourist development at Coles Bay
- Replacement of the Sorell causeway bridge and realignment of the causeway
- Construction of a wharf facility at Electrona

- Desktop investigations of the impacts of aquaculture and other anthropogenic activities on the marine environment of the South East Region of Australia – National Oceans Office
- Macrobenthic monitoring in receiving waters adjacent to a woodchip plant
- A proposed marina facility in the Derwent Estuary
- Foreshore access options at Battery Point, Hobart
- A preliminary literature review and assessment of ecological issues for a marina village development at Lauderdale
- Oyster Cove marina extension - baseline ecological and pollutant survey
- Port Huon marina development - baseline ecological and pollutant survey
- Wine estate expansion, baseline environmental survey of adjacent creek entrances and Moulting Lagoon

Aquenal is currently working on an NRM South funded project (2006) to determine baseline condition benchmarks and establish reference sites for key foreshore habitats. This will identify key pressures as the basis for measuring impacts on key marine and coastal ecosystems.

Other consultancies and enterprises

Other consultancies (e.g. Earth Tech Engineering, Sinclair Knight Merz, Inspiring Place Pty Ltd., Ecosynthesis and Phycotec Environmental Management) also conduct environmental assessments, risk and impact assessments and surveys. Some of these projects include:

- River condition index framework for Tasmania (current NRM project 2006 – Earth Tech Engineering)
- Catchment management plans (e.g. Sinclair Knight Merz 2002, Sinclair Knight Merz 2001)
- Environmental Impact Assessments (e.g. Cockle Creek eco-tourism development, de Gryse and Hepper 2000)
- Auditing harmful algal blooms, fish and shellfish mortality (Phycotec Environmental Management)

Forestry Tasmania also conducts periodic water quality sampling in the main freshwater systems above and below forestry activities (e.g. Meyer and Lynch 1999). Parameters monitored include turbidity, conductivity, pH and temperature.

Water quality data is also collected by salmonid and shellfish farmers in the Huon Estuary, D'Entrecasteaux Channel and Tasman Peninsula.

Community groups

There are a variety of ways that communities are involved in water quality monitoring and NRM in general. Many landholders, businesses and industries address natural resource management issues (such as weed and pest control, remnant vegetation protection, revegetation, soil testing and water monitoring) as part of their property maintenance.

Additionally, groups are formed by interested members of the community and in many areas these groups provide important vehicles for community participation.

The type and extent of monitoring that is conducted often reflects the reason a group or individual became involved in water quality monitoring. For example, the main considerations for land holders are the extent of natural resources or how the threat to natural resources will affect land productivity, the financial costs/benefits of NRM and time constraints. Alternatively, many Tasmanian primary and secondary schools and colleges carry out monitoring programs as a way of teaching students about environmental and natural resource management issues.

There are approximately 168 Landcare, Coastcare, Waterwatch and 'Friends of' groups ("Care" groups) active in Southern Tasmania, the majority of which are based in the urban area of Greater Hobart (55%). These groups often reach a large number of people within their local communities through their newsletters, publications and activities. Most of these groups primarily perform onground works such as revegetation and weed control. There are very few groups currently monitoring water quality in the Region – and the few groups that have been involved in monitoring have concentrated on freshwater systems. Some of the community groups are based in coastal/estuarine areas (Table 8).

Table 8. Community Initiatives in coastal/estuarine areas in NRM South.

Catchment	Community Initiatives
Davey	There are no registered "Care" groups in this location. However, several groups have undertaken work in the WHA – Wildcare, and recreational groups (e.g. walking/rafting)
Huon	Southport Coastcare Group, Dover Coastcare Group, Huon Healthy Rivers Program, Castle Forbes Bay Landcare Group Inc., Surveyors Bay Coastcare, Franklin Primary Junior Landcare Group, Port Cygnet Landcare, Cygnet Landcare, Cygnet Junior Landcare, Port Cygnet Landcare and Watercare Group Inc., Friends of Port Cygnet
Derwent Estuary-Bruny	Little Oyster Cove Waterwatch, Kingston Beach/Browns River Coastcare Group, Friends of Stink Pot Bay/Coastcare, Howden Landcare Group, North West Bay River Catchment Committee, Snug Coastcare Landcare, Kettering Coast/Landcare Group, Friends of Conningham Natural Recreational Area, Oyster Cove, Lower Snug (FOCOCL), Cremorne Coastal Wetland Group, Derwent Estuary Program, Newtown Rivulet Catchment Care Group Inc., Derwent Catchment Waterwatch Group Inc., and many other local "Care" groups
Tasman	Bangor Landcare Inc., Marion Bay Coastcare Inc., Eaglehawk Neck Coastcare, Roaring Beach Coast / Landcare Group, Stewarts Bay Coastcare, White Beach Landcare Group, Port Arthur Landcare
Pitt Water-Coal	Pitt Water Catchment Project Group, Midway Point Landcare; Orielton Lagoon Action Committee; Penna Landcare Group Inc., Southern Beaches Landcare/Coastcare, South East Waterwatch
Little Swanport	Little Swanport ManagemnetCatchment Group, Little Swanport Estuary Land/Coastcare Group
Prosser	Orford Primary School Waterwatch, Spring Beach Coastcare, Spring Bay Landcare
Swan-Apsley	Denison Catchment Waterwatch Group, Dolphin Sands Landcare, Saltwater Creek Waterwatch, Tidy Towns Swansea, Glamorgan Spring Bay Waterwatch

Many "Care" groups produce area-specific management plans to provide a strategic direction and priorities for onground works. These provide a strong basis for funding applications (justification for funding) and reporting on the outcomes of the completed work. Management plans are often subcontracted to environmental consultants (individuals or bodies such as Greening Australia) or, where the land occurs within a

reserve, written by Parks and Wildlife Service Tasmania staff. Monitoring activities (including water quality monitoring) can (and should) be included in the implementation of management plans to demonstrate change (due to development) or to demonstrate the success of onground works (such as foreshore stabilisation due to revegetation activities).

Where are the gaps in the existing knowledge?

The Tasmania Monitoring and Evaluation Trial (NLWRA 2005) identified gaps in data and requirements for new data collection for the natural resource condition targets contained in the Draft NRM Strategy for Southern Tasmania – including estuarine and coastal ecosystems. The main estuarine and coastal water quality issues identified through this process were that: (a) long term trends in water quality are poorly understood due to a lack of broad-scale monitoring and ongoing data collection; and (b) nutrients, turbidity and salinity of estuaries of critical and high conservation significance are poorly understood. The NLWRA (2005) recommended that an ongoing systematic monitoring program is required, including more robust baseline monitoring of nutrients, turbidity and salinity. The NLWRA (2005) also identified issues with regard to monitoring (e.g. no ongoing funding program), evaluation (e.g. variable methodologies applied in projects) and other gaps (e.g. data requiring updating, limited geographical coverage).

The deficiency in regular and consistent monitoring of coastal, marine and estuarine environments means that it is difficult to assess the impact (both positive and negative) of activities within these environments and their catchments. Without the knowledge that such monitoring generates, it is difficult for managers and stakeholders to make resource-efficient management decisions. There is a need for more information on the baseline condition for water quality and improved monitoring of reference sites (e.g. pristine/near pristine waters). An approach to monitoring needs to be standardised across locations, and the levels of data "quality" need to be assured. It is also important that the trigger levels for determining unacceptable levels of impact continue to be developed and communicated.

A lack of resources is the main deficiency in the collection and management of water quality information in Tasmania, and this problem spans across programs. The NRM South CERCA project aims to address these issues by developing and implementing an integrated water quality monitoring framework for estuaries including:

- A co-ordinated and strategic system for monitoring and reporting
- A long-term framework/plan (including finance requirements and funding options)
- An implementation strategy
- Partnership agreements or Memoranda of Understanding to facilitate co-ordination between programs and optimise funding, equipment and personnel
- A system for data management (e.g. centralised, versatile database)
- A mechanism for data distribution and reporting (e.g. report cards)

This program will provide a guide for regional investment and it is therefore important that marine and coastal stakeholders are involved in the planning of priorities and management targets.

Identification of priority locations for monitoring

Prioritising areas for monitoring

At any one time it is unlikely that there will be sufficient resources to monitor all waters in the Region. It is therefore necessary to determine which estuaries and coastal waters are the priority for monitoring.

A number of factors were considered to determine priorities, which can be broken into three parts: (a) significance of the location, (b) practicality of monitoring, and (c) capacity for collaboration. The considerations are quite broad and may be conflicting, reflecting the wide range of issues and potential uses of estuaries and coastal waters in the Region.

In no way does this process seek to rank one location as being of more "value" than another, only as a process for considering potential locations for the initial stages of implementation (i.e. locations that have a high likelihood of successful implementation given resource constraints).

Large-scale studies, programs and/or frameworks exist for the Derwent (e.g. Green and Coughanowr 2003) and Huon (e.g. Butler *et al*. 2000, Woods *et al*. 2004) estuaries, so although they are significant locations, they have been excluded from selection. The Derwent Estuary Program is ongoing and is committed to working co-operatively with the NRM South CERCA program (pers comm. Ruth Eriksen).

Significance of the location

Key estuaries and coastal waters have been chosen to reflect a range and diversity of characteristics within these waters and their catchments. These include geomorphology, condition, usage (recreation, tourism, fishing, rafting, bushwalking, hunting, swimming), agriculture, forestry and hydro-power generation) conservation significance and municipalities (see Chapter 3). The aim is to select a representative range of coastal areas and estuaries, spread across the municipalities as much as possible. Similarly, it would be ideal to select a range of locations across degraded and near-pristine locations (e.g. Edgar *et al*. 1999 and as prioritised by CFEV).

It is preferable that the monitored estuaries are spread geographically throughout the NRM South Region so all representative areas of the Region are included in a monitoring program. It is also crucial that estuaries and coastal waters selected for monitoring have interested, informed and committed stakeholder groups that can form linkages within an integrated monitoring program. Other aspects that have been considered to determine priorities include the relevance/significance to community groups/government/industry and the level of threat or degradation to the ecosystem.

The proposed monitoring location is valued for its significance if there is:

- other industry present (e.g. marine farming)
- recreational use (swimming, surfing, boating, fishing/hunting, other)

- special values (e.g. threatened species, threatened communities, migratory birds, geomorphology and other significant activities)
- there is some degree of monitoring underway
- a large permanent population or a large holiday population (shacks)
- high conservation management priority

If a proposed area has a high to moderate risk of detrimental change to land or water use, it will be considered to be a higher priority than those with a low risk of change to land or water use. Similarly, if the habitat and catchment of the proposed monitoring location are adequately reserved/protected (e.g. significant area of the catchment protected in National Parks or other reserve, location contains a MPA or Ramsar site) and it is classed as pristine or near-pristine and/or known as a location for a threatened species, it will be considered a higher priority.

For estuaries, CFEV conservation management priorities take into account important factors such as data from Edgar *et al.* (1999) (representativeness and condition), special values and land tenure security. Representative Conservation Value (RCV) defines broad conservation objectives and selects at least one of each class (those that are highly representative of their biophysical class). The Integrated Conservation Value (ICV) considers special values (threatened species, threatened communities, migratory birds and geomorphology) (see Table 9). The process is used to determine priorities for improved conservation management.

In comparison to estuaries, coastal waters are much harder to categorise and define (as they are open systems without defined boundaries). This makes prioritisation difficult, and is one explanation for the lack of past monitoring in these systems. Here, we have defined key coastal waters as those with industry/commercial enterprises present (e.g. marina, finfish farming, shellfish farming), stormwater/sewage outfalls and cultural significance (e.g. historical, recreational (e.g. fishing), and Aboriginal value).

Although these criteria form the basis for prioritisation, circumstances may change if an area has been subject to a significant event (e.g. an oil spill is a catastrophic event that could make a perceived low priority estuary a higher priority). In these circumstances, monitoring will be required to determine initial impact and whether recovery / rehabilitation have occurred.

Practicality of monitoring

At this stage, it is considered practical to select 6 locations due to resource restrictions. Additionally, monitoring in a particular location is considered practical if:

- the proposed monitoring location is readily accessible,
- there is a framework or funding opportunities (existing or proposed) for monitoring efforts to continue, and
- an established report recommends a water quality monitoring regime

Capacity for collaboration

A proposed monitoring location will be considered a priority if water quality monitoring will contribute to a catchment-wide focus. This has been considered through linkages with the program *Establishing Surface Water Quality Baselines to Set Trigger Levels for Resource Condition Targets* (pers comm. Cliff Massey, Hydro Consulting) and by aligning priorities with the DPIW water quality programs (e.g. Waterways). All water quality monitoring activities were considered for each proposed location to assist with gap and capacity analysis (see Table 9 and Appendix 3). To maintain simplicity, a weighting mechanism for the criteria examined for priority selection was not applied.

Table 9. Summary of outcomes for the selection of key sites based on past programs and the likelihood of successful implementation of a CERCA framework.

				TAFI					DPIW											Other				
Coastal area	Accessible by road	SMEC/Thiess 1999	Large-scale program (DEP, HES, CSIRO)	Edgar *et al.* 1999	Murphy *et al.* 2003	Seamap project	Other	Marine Farming Plans	Waterways	CFEV ICV*	CFEV RCV**	CFEV CMP***	Pesticides	Water Management Plans	TSQAP	Parks and Wildlife Services	Catchment Management Plan (all)	Environmental Impact Statement (all)	Geoscience Australia	Council data	Other Community data	Other survey/assessment	Community potential	TALLY TOTAL
Bathurst Harbour			X	X		X	X			X	X	X				X			X			X		10
Blackman Bay	X			X		X		X		X					X				X				X	8
Browns River	X		X	X	X			X											X	X			X	8
Bryans Lagoon				X		X						X				X			X					5
Buxton	X			X							X								X					4
Carlton	X			X					X				X					X	X		?		X	7
Catamaran	X	X		X	X	X					X	X							X					8
Cloudy Bay	X			X	X	X		X			X	X			X	X			X					10
Cockle Creek	X	X		X	X											X		X	X					7
Crookes	X			X															X					3
Denison	X			X													X		X	X	X		X	7
Derwent	X		X	X		X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	19
D'Entrecasteaux	X			X		X	X	X			X	X			X								X	9
Earlham Lagoon	X			X	X					X	X	X			X				X					8
Esperance	X	X		X				X	X				X		X			X	X	X				8
Freney Lagoon				X							X	X							X					4
Freshwater Lgn				X															X					2
Garden Island Ck	X		X	X				X											X					5
Great Swanport	X			X	X	X		X	X	X	X	X			X	X			X		X	X		14
Grindstone	X			X				X											X					4
Huon	X	X	X	X		X		X	X		X	X	X				X	X	X	X	X	X	X	17
Lisdillon	X			X				X											X					4
Little Swanport	X			X	X	X	X	X	X	X			X	X	X		X		X	X	X		X	16
Louisa Creek				X															X					2
Louisa River				X															X					2
Lune River	X	X		X				X								X		X		X			X	8
Meredith	X			X	X			X	X				X		X				X	X			X	10
New River Lagoon				X						X	X	X							X					5
Norfolk Bay	X					X	X	X	X				X		X						?		X	8
North West Bay	X	X		X		X	X	X									X	X	X	X	X	X	X	13
Oyster Cove	X					X		X							X			X		X	X	X	X	9
Payne Bay				X					X	X	X	X							X					6
Pipe Clay Lagoon	X			X		X	X	X							X	X			X				X	8
Pirates Bay	X					X															X		X	4
Pitt Water	X			X		X	X	X	X	X			X		X	X	X	X	X			X	X	15
Port Arthur	X					X	X	X							X				X			X	X	8
Port Cygnet	X	X	X	X											X		X	X	X	X	X		X	11
Prosser	X			X		X			X				X				X		X	X	X		X	10
Saltwater Lagoon				X							X	X							X					4
South Cape Rvt				X															X					2
Southport Lagoon	X			X		X	X				X	X				X		X	X			X		10
Spring Bay	X			X		X		X							X		X	X	X	X			X	10
Stony	X			X															X					3

* Ranked as Very High ICV (includes assessment of Special Values), ** Ranked as A-class RCV, *** Ranked as Very High Conservation Management Priority (to protect and maintain freshwater ecosystem values) (includes assessment of Special Values).

Key estuaries and coastal waters

A framework for CERCA will be developed in the locations identified as priorities through the process of consultation with stakeholders, this discussion paper, and consideration by the CERCA Review Panel. The suggested locations for implementing the CERCA framework are:

- Great Swanport/Moulting Lagoon (Glamorgan Spring Bay Council, highly representative and moderate condition, RAMSAR listed wetland, baseline assessment of Shelbourne Bay conducted in 2005 with support from Parks and Wildlife, DPIW, TAFI and Aquenal Pty. Ltd.)
- Little Swanport (Glamorgan Spring Bay Council, moderate condition, estuarine monitoring currently being conducted by TAFI, TSQAP and the oyster farmers)
- Pitt Water/Orielton (Clarence City Council/Sorell Council, poor condition, RAMSAR listed wetland, previously monitored by TAFI, currently being monitored by TSQAP)
- North West Bay (Kingborough Council, poor condition, baseline assessment conducted by TAFI and Council in 2002, fish farm monitoring)
- Port Cygnet (Huon Valley Council, poor condition, some estuarine monitoring being conducted by community, TSQAP and fish farmers)

The Derwent and Huon estuaries received the highest priority in the selection process, however since large-scale studies, programs and/or frameworks already exist in these locations, they were excluded from selection. Other high scoring locations were also eventually excluded to maintain geographic spread throughout the Region (e.g. Meredith, Prosser and Spring Bay) or because of their remoteness (e.g. Bathurst Harbour).

Southport Lagoon was initially identified as a priority location for implementing the CERCA framework Southport. Subsequent discussions with stakeholders and the CERCA Review Panel have indicated that regular monitoring of Southport Lagoon is not feasible due to its remoteness. There is no road access to Southport Lagoon at present, and the only legal access to the Lagoon is via small boat through the Lagoon entrance and by foot along the 4WD track from the end of the Ida Bay Railway. Lagoon entrance by sea is risky (seasonal and weather dependant) and should only be attempted by an experienced coxswain familiar with the Lagoon and only in suitable conditions. Feasibility may change in the future as high clearance 4WD access will be available (approximately by Autumn 2007) to the western side of the lagoon and stairs constructed down the bank to facilitate launching of “car top” dinghies – trailers are not suitable.

Project directions

This discussion paper with recommended estuaries for monitoring will be circulated to a CERCA review panel and key stakeholders for comment by 19 January. These comments will be considered when the final recommendations of key estuaries and coastal waters are made.

Once priority locations have been identified, a draft CERCA framework will be prepared for estuaries and coastal waters. The framework will include an initial implementation strategy which will be reviewed after a 12 month time period to increase the likelihood of the CERCA program being successful in the long term.

This framework will consider selection of sampling sites and recommendations of environmental variables to be monitored. These will be based on the NRM Estuarine, Coastal and Marine Indicator list, developed as part of the Tasmanian Indicator Compendium, which is available (draft) online (http://www.dpiw.tas.gov.au/inter.nsf/ThemeNodes/CDAT-593VMB?open). The methods for monitoring each indicator will be based on a report prepared by Christine Crawford at TAFI, which provides information from a user's perspective on monitoring each indicator in Tasmania (Crawford 2006). The framework will also assess the practicalities of running a monitoring program including how often to monitor, what samples to collect, equipment required etc. Consideration of stakeholder capabilities and future facilitation is a critical part of successfully implementing the monitoring program. Stakeholders' input into discussion of their capabilities for ongoing monitoring will therefore be important. Baseline monitoring will subsequently commence in the key estuaries and coastal waters.

The CERCA framework will also recommend a system for data management (e.g. centralised, versatile database) and a mechanism for data distribution, interpretation and reporting (e.g. annual report cards). Once the draft framework has been reviewed, it will be tested and evaluated to produce the final framework and initial report cards on the condition of the estuaries and coastal waters being monitored.

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Appendices

Appendix 1: Communication Strategy for a Coastal and Estuarine Resource Condition Assessment Framework:

Target	Message/Aim	Media
Community groups	• Project exists • Invitation to participate on a limited basis, information sharing • Community participation is valued • How they can use the info/how it will be useful to them • What the end product will be	Information Article to: • Newsletters • Local newspapers • Bulk email/mailing lists • Meetings • Workshop?
Council/Local government	A. ELECTED COUNCIL: • Project exists • Benefits for them i.e. convince them to support project • Streamline water quality monitoring (share costs and benefits) • Value to local government will be able to participate in decision making B. COUNCIL STAFF • Project exists • Invite to participate • Value • Information	• Direct letter • Council newsletter • LGAT bulk letter through their mail merge system • LGAT newsletter • Letter to GM • Contact EHOs & NRM Officers
Industries • Type • Impact • Location • Number	• Project exists • Invitation: participation will help with compliance requirements • Catchment approach (why it is in their interest)	• Information package/flyer • Invite to participate • Personal visit for any follow up
Scientists/researchers and compliance programs	• Who/what/where • DEP	• Letter to DEP • Follow up meetings
"User" Groups • Rec fishers • Yachting • Motor boats • Power boats • Hunting groups • Kayaks • Surf	• Project exists • Awareness raising (esp. marine pests and marine debris) • Any invitation for these groups to participate should come from community groups or council	• Information package/flyer • Use appropriate/group specific images • Articles in relevant printed media
State Government	• Project exists • Information/collaboration	• Letter/Information package/ • Follow up meetings
Broad community	Project exists/completed: On completion of stage one (framework) or initiation of stage two (trial) To increase prestige for project and awareness raising	General media release: TV, radio, newspaper

Appendix 2: Summary table of Protected Environmental Values (PEVs) for NRM South (DPIWE, 2000; DPIWE, 2003).

Location	Value	Area	Area qualifier	Example	A	B	C	D	E
Glamorgan-Spring Bay	Land values	Private land			(ii) a	(i), (ii), (iii)	(i)		Y - Industrial water supply
		Forest Reserves	head waters originate in		(i)	(i), (ii), (iii)			
		Forest Reserves	waters flow through		(ii) a	(i), (ii), (iii)			
		National Parks, State Reserves, Nature Reserves and historic sites	head waters originate in		(i)	(i), (ii), (iii)	(i)		
		National Parks, State Reserves, Nature Reserves and Historic Sites	waters flow through		(ii) a	(i), (ii), (iii)			
		Nature Recreation Areas, Conservation Areas or Game Reserves	head waters originate in		(i)	(i), (ii), (iii)	(i)		
		Nature Recreation Areas, Conservation Areas or Game Reserves	waters flow through		(ii) a	(i), (ii), (iii)			
		Public reserves	head waters originate in		(i)	(i), (ii), (iii)			
		Public reserves	waters flow through		(ii) a	(i), (ii), (iii)			
		Unallocated Crown Land			(ii) a	(i), (ii), (iii)			
		Commonwealth Land			(ii) b	(i), (ii), (iii)			
		State Forest			(ii) a	(i), (ii), (iii)			
	Estuarine values	National Parks, State Reserves, Nature Reserves, Historic Sites, Nature Recreation Areas, Conservation Areas or Game Reserves	enclosed?	Moulting Lagoon	(ii) a	(i), (ii), (iii)			Y - Industrial water supply (Aquaculture in Marine Farming Zone in Moulting Lagoon Game Reserve)
		excluding above	semi-enclosed?	Little Swanport & Lisdillon	(ii) a	(i), (ii), (iii)			Y - Industrial water supply (Aquaculture in Marine Farming Zone)
Huon	Land values	Wellington Park			(i)	(i), (ii), (iii)			
		Private land			(ii) a	(i), (ii), (iii)	(ii)	(i), (ii)	Y - Industrial water supply (Aquaculture, Commercial bottling of spring water, on-farm produce processing, produce processing)
		Creeks			(ii) a	(i), (ii), (iii)	(i), (ii)		
		Forest Reserves	head waters originate in		(i)	(i), (ii), (iii)			
		Forest Reserves	waters flow through		(ii) a	(i), (ii), (iii)			
		National Parks, State	entire		(i)	(i), (ii), (iii)			

		Reserves, Nature Reserves and historic sites							
		National Parks, State Reserves, Nature Reserves and Historic Sites	waters flow through from private land		(ii) a	(i), (ii), (iii)			
		Private land (aboriginal Land Council)			(i)	(i), (ii), (iii)			
		Bathurst Channel & Port Davey			(i)	(i), (ii), (iii)			
		Nature Recreation Areas, Conservation Areas, Game Reserves or Regional Reserves	entire		(i)	(i), (ii), (iii)			
		Nature Recreation Areas, Conservation Areas, Game Reserves or Regional Reserves	waters flow through from private land		(ii) a	(i), (ii), (iii)			
		HEC land			(ii) a	(i), (ii), (iii)			Y - Industrial water supply
		Public reserves	waters flow through		(ii) a	(i), (ii), (iii)			
		Public reserves	head waters originate in		(i)	(i), (ii), (iii)			
		Unallocated Crown Land			(ii) a	(i), (ii), (iii)			
		State Forest			(ii) a	(i), (ii), (iii)			
	Estuarine values	Outside SW National Park and Southport Lagoon Conservation Area			(ii) a	(i), (ii), (iii)			Y - Industrial water supply (Aquaculture in Marine Farming Zone)
Kingborough/D'Entrecasteaux Channel	Land values	Wellington Park			(i)	(i), (ii), (iii)	(ii)		
		Private land			(ii) a	(i), (iii), (iv)		(i), (ii)	Y - Industrial water supply (Blue Metal Industries)
		Forest Reserves	head waters originate in		(i)	(i), (ii), (iii)			
		Forest Reserves	waters flow through		(ii) a	(i), (ii), (iii)			
		National Parks, State Reserves, Nature Reserves and historic sites	entire		(i)	(i), (ii), (iii)			
		National Parks, State Reserves, Nature Reserves and Historic Sites	waters flow through from private land		(ii) a	(i), (ii), (iii)			
		Nature Recreation Areas, Conservation Areas, Game Reserves or Regional Reserves	entire		(i)	(i), (ii), (iii)			
		Nature Recreation Areas, Conservation Areas, Game Reserves or Regional Reserves	waters flow through from private land		(ii) a	(i), (ii), (iii)			
		Public reserves			(ii) a	(i), (ii), (iii)			

		Unallocated Crown Land			(ii) a	(i), (ii), (iii)			
		State Forest			(ii) a	(i), (ii), (iii)			
	Estuarine values	Waters within D'Entrecasteaux Channel excluding MPAs			(ii) a	(i), (ii), (iii)			Y - Industrial water supply (Aquaculture in Marine Farming Zone)
		NW Bay			(ii) a	(i), (ii), (iii)			Y - Industrial water supply (Aquaculture in Marine Farming Zone)
		MPAs			(iii)	(i), (ii), (iii)			
South East Coast	Land values	Private land			(ii) a	(i), (ii), (iii)	(i)	(i), (ii)	Y - Industrial water supply (land based fish-farming, chicken processing)
		Private Nature Reserve			(ii) a	(i), (ii), (iii)			
		Forest Reserves	head waters originate in		(i)	(i), (ii), (iii)			
		Forest Reserves	waters flow through		(ii) a	(i), (ii), (iii)			
		National Parks, State Reserves, Nature Reserves, Nature Recreation Areas, Conservation Areas, or Game Reserves	head waters originate in		(i)	(i), (ii), (iii)			
		National Parks, State Reserves, Nature Reserves, Nature Recreation Areas, Conservation Areas, or Game Reserves	waters flow through		(ii) a	(i), (ii), (iii)			
		Historic sites	head waters originate in		(i)	(i), (ii), (iii)			
		Historic sites	waters flow through		(ii) a	(i), (ii), (iii)			
		Public reserves	head waters originate in		(i)	(i), (ii), (iii)			
		Public reserves	waters flow through		(ii) a	(i), (ii), (iii)			
		Unallocated Crown Land			(ii) a	(i), (ii), (iii)			
		Commonwealth Land			(ii) a	(i), (ii), (iii)			
		State Forest			(ii) a	(i), (ii), (iii)			
	Estuarine values	National Parks, State Reserves, Nature Reserves, Historic sites, Nature Recreation Areas, Conservation Areas, or Game Reserves	in	Orielton, Barilla Bay and Upper Pitt Water	(ii) a	(i), (ii), (iii)			
		National Parks, State Reserves, Nature Reserves, Historic sites, Nature Recreation Areas, Conservation Areas, or Game Reserves	not in		(ii) a	(i), (ii), (iii)			

		Southern Pitt Water			(ii) a	(i), (ii), (iii)			
Derwent	Land values	Nature Recreation Areas, Conservation Areas or Regional Reserves			(i)	(i), (ii), (iii)			
		Wellington Park			(i)	(i), (ii), (iii)	(ii)		
		Public reserves	waters flow through		(ii)	(i), (ii), (iii)			
		Public reserves	head waters originate in		(i)	(i), (ii), (iii)			
		Unallocated Crown Land			(ii)	(i), (ii), (iii)			
		Commonwealth Land			(ii)	(i), (ii), (iii)			
		HEC land			(ii)	(i), (ii), (iii)			Y - Industrial water supply (Hydro electric power generation)
	Hobart Water	All catchments			(i)	(i), (ii), (iii)	(ii)		
		Private land	waters flow through		(ii)	(i), (ii), (iii)	(ii)		Y - Industrial water supply
		Private land	head waters originate in		(ii)	(i), (ii), (iii)	(ii)		Y - Industrial water supply
		Unallocated Crown Land	waters flow through		(ii)	(i), (ii), (iii)	(ii)		
		Unallocated Crown Land	head waters originate in		(ii)	(i), (ii), (iii)	(ii)		
		Public reserves	waters flow through		(ii)	(i), (ii), (iii)	(ii)		
		Public reserves	head waters originate in		(ii)	(i), (ii), (iii)	(ii)		
		Nature Recreation Areas, Conservation Areas or Regional Reserves			(ii)	(i), (ii), (iii)	(ii)		
Derwent Valley	Land values	Wellington Park			(i)	(i), (ii), (iii)			
		Private land	in Central Highlands and Derwent Valley Municipalities		(ii) a	(i), (ii), (iii)	(ii)	(i), (ii)	Y - Industrial water supply (Aquaculture, Pulp & paper mil, Hydro electric power generation)
		Private land	in Brighton Municipality		(ii) a	(i), (ii)		(i), (ii)	
		Forest Reserves	head waters originate in		(i)	(i), (ii), (iii)			Y - Industrial water supply (Hydro electric power generation)
		Forest Reserves	waters flow through		(ii) a	(i), (ii), (iii)			Y - Industrial water supply (Hydro electric power generation)
		National Parks, State Reserves, Nature Reserves or historic sites	entire		(i)	(i), (ii), (iii)	(ii)		Y - Industrial water supply (Hydro electric power generation)
		National Parks, State Reserves, Nature Reserves or historic sites	waters flow through		(ii) a	(i), (ii), (iii)			Y - Industrial water supply (Hydro electric power generation)
		Nature Recreation Areas, Conservation Areas and	entire		(i)	(i), (ii), (iii)			Y - Industrial water supply (Hydro electric power

		Game Reserves							generation)
		Nature Recreation Areas, Conservation Areas and Game Reserves	waters flow through		(ii) a	(i), (ii), (iii)			Y - Industrial water supply (Hydro electric power generation)
		Public reserves	head waters originate in		(i)	(i), (ii), (iii)			Y - Industrial water supply (Hydro electric power generation)
		Public reserves	waters flow through Brighton		(ii) a	(ii), (iii)			Y - Industrial water supply (Hydro electric power generation)
		Public reserves	waters flow through Other		(ii) a	(i), (ii), (iii)			Y - Industrial water supply (Hydro electric power generation)
		Unallocated Crown Land			(ii) a	(i), (ii), (iii)			Y - Industrial water supply (Hydro electric power generation)
		HEC land			(ii) a	(i), (ii), (iii)			Y - Industrial water supply (Hydro electric power generation)
		Commonwealth Land			(ii) a	(ii), (iii)			
		State Forest			(ii) a	(i), (ii), (iii)	(ii)		Y - Industrial water supply (Hydro electric power generation)

Appendix 3: Summary of Water Quality Monitoring Programs in NRM South.

Reference: This is a revised metadatabse from SMEC Victoria/Thiess Environmental Services 1999, including updated information from individual programs, new programs and others that warrant inclusion (e.g. marine/estuarine programs). The tables include information on which Protected Environmental Values (PEVs) are addressed by each program. These are: Pristine or nearly pristine ecosystems, Modified (not pristine) ecosystems from which edible seafoods are or are not harvested, Recreational water quality for primary and secondary contact or aesthetics only, Raw water for drinking water supply, Agricultural water use for irrigation or stock watering, and industrial water supply.